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SCIENTIFIC [illegible]

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. XIV MAY, 1919 No. 5

SOME BACTERIOLOGIC PHASES OF THE CHOLERA-CARRIER PROBLEM

By JOHN A. JOHNSTON

(From the Biological Laboratory, Bureau of Science, Manila)

It has been tersely stated by Munson(3) that the dangerous nature of frank cases of cholera with diarrhœa, vomiting, and collapse is well recognized by the people and consequently would be avoided, reported, isolated, and followed by disinfection of their environment; in short, cases of this nature would not occasion a health department great anxiety. The cholera carrier, however, is to be regarded with concern by health officials as a dangerous source of infection; for, having no symptoms, he is not considered a menace, and may go about infecting privies, food, drinks, and those who come in contact with him.

The Sanitary Commissioner of India says:(6)

> The part played by the Kumbh fair at Hardwar in the dissemination of cholera infection in the United Provinces has already been referred to; in the Punjab this fair seems to have played an even more definite part in the spread of this disease. It is very significant that the year 1903 was the date of the previous Kumbh fair. Cholera was practically absent from the Punjab during the first three months of the year but in April pilgrims returning from Hardwar spread the infection far and wide and during the next six months most districts suffered more or less severely.

A few figures here may not be amiss: From July 1 to November 1, 1914, some 30,000 specimens of fæces from prisoners in Bilibid, not cholera suspects, were examined and 1.75 per cent found to be positive.

The fact that an individual is a cholera carrier does not give immunity. Prisoners 8617, 12765, and 30351 were found positive on September 10 and 11, 1914. They were isolated, and their fæces were examined every other day and found continuously positive. No. 8617, after having been a carrier for seventeen days, became ill with frank cholera; No. 12765 was a carrier for sixteen days before he came down with the disease, and No. 30351, for eighteen days; the last-mentioned individual died of the disease.

The question naturally arises: What is the cause of development of cholera in carriers? In so far as our present knowledge of the subject goes this is an unanswerable question. For want of anything more definite, it may be said in a general way that a lowering of vital resistance permits invasion. If this hypothesis be true, then we can easily understand how a carrier may become a victim to the disease at this time. But not everything is explained even by the theory of lowered vital resistance; it is still an open question. Some workers are inclined to believe that the organism itself, as occurring in persons of carriers, fluctuates in virulence; but this belief is scarcely tenable, and may be dismissed with scant discussion. However, it may be that the cholera vibrio requires passage through an intermediate human host before causing symptoms. My own observations are to the effect that the vibrios isolated from a carrier, either while living or after death, behave in exactly the same manner as do those obtained from a frank cholera case; there is absolutely no difference.

Once a cholera carrier, how long does this condition exist? This is a question of the greatest importance for the health officer. The answer can only be obtained from the laboratory, and unfortunately we are unable to answer definitely. We know that in the typhoid carrier the period of infection lasts for years, very likely for the life of the individual. Some observations made on prisoners in Bilibid would seem to indicate that very likely the cholera-carrier state may be of indefinite duration. Prisoner 8841 was positive on September 12, 1914, had seven negative examinations at intervals of four days, was released from quarantine, and was not reëxamined until July 15, 1916, when he was positive again; negative until September 10, when he was once more positive; negative until December 31; positive again January 13 and 18, 1917; negative on January 24, but a nonagglutinable vibrio was isolated; January 25, 27, 30, and February 3, respectively, a nonagglutinable vibrio was isolated; February 7 he was once more positive; February 10, 15, 17, 20, 22, 27, and March 1, respectively, a nonagglutinating vibrio was isolated; March 3 he was again positive; March 6 and 8, respectively, a vibrio was found; March 15 he was negative and remained so to December, 1917.

Prisoner 8472 was positive September 28, 1914, and then had eight negative examinations at intervals of four days; he was found positive again July 13, 1916.

No. 9638 was found positive January 17, 1915, followed by eight negative examinations at intervals of four days; he was again positive July 13, September 13, and December 1, 1916, and has not been positive again.

Is it not reasonable to suppose that these men harbored the cholera vibrio for periods of one and two years? If this be true, why not for longer periods of time?

No. 11040 was positive for the first time August 2, 1916; negative until September 22; again negative until October 19; negative again until November 25; negative, November 29; positive, December 3; negative, December 15 and 16; December 20 a nonagglutinable vibrio was isolated; negative, December 23 and 29; on January 8 and 11, 1917, respectively, a nonagglutinable vibrio; January 18, positive; January 20, 24, 25, and 27, respectively, a nonagglutinable vibrio; January 30, negative; February 3, a nonagglutinable vibrio; February 7, positive; February 10, 15, 17, and 27, respectively, a nonagglutinable vibrio; March 1, negative; March 3, positive; March 6 and 8, negative; April 3 and 4, positive; and since then, negative to December.

I have records of many other cases that I could cite, but these are sufficient to show the irregularity with which positive results occur. I believe this irregularity is more apparent than real; for I believe that, if a cholera carrier were kept under exactly the same conditions of temperature, humidity, and surroundings; given the same food and the same work; and if the specimens were taken at the same time of day, in the same way, and transmitted to the laboratory under exactly the same conditions, the number of positive results would be more than doubled.

The researches of Schöbl(7) and of Schöbl and Pañganiban(8) on cholera carriers in guinea pigs have shown that food plays an important rôle in the appearance and the disappearance of the vibrios in the fæces. The normal period for recovery of the cholera vibrios from artificially infected guinea pigs has been definitely established to be approximately fourteen days, after which time they can no longer be found. If bile is administered, however, these same animals continue to excrete the vibrios for indefinite periods, the exact length of time not having been determined definitely.

In 1916, in Bilibid Prison,(4) 600 carriers (8.2 per cent of the population) were found; a total of 112,577 stool examinations were made. A word as to the technic: A sterile swab was plunged into each man's fæces and thus inoculated; this swab was placed in a test tube containing about 2 cubic centimeters of plain agar of a reaction of —1.0 to phenolphthalein. The purpose of the agar is simply to prevent the drying out of the inoculum. Upon receipt at the laboratory, 10 cubic centimeters of a 2 per cent peptone solution were added, and the tubes incubated over night. In the morning hanging drops from these peptone tubes were examined for suspicious motility, and the tubes showing it were set aside for further culturing. Dieudonné plates were used and, after streaking, were incubated for a further twenty-four hours. All suspicious colonies were fished out, emulsified in a sterile salt solution, and tested for agglutination. For the latter test an immune serum having a titer of 1 to 4,000 was used in a dilution of 1 to 500. The cholera vibrio agglutinates promptly with this, and nothing but the true cholera vibrio will give a positive reaction. There are vibrios, however, that correspond with the true organism in every way except agglutination; these may or may not be true cholera vibrios. The majority of these vibrios are hæmolytic; that is, in blood-agar plates a clear zone of hæmolyzed blood is produced about the colony. Some authors have reported strains of cholera vibrios producing hæmolysis also. In the light of our present knowledge, however, it may be safely accepted that any vibrio that does not agglutinate promptly on being brought into contact with a drop of a 1 to 500 dilution of a known cholera-immune serum of high titer is not a true cholera vibrio.

That these nonagglutinating vibrios bear some more or less intimate relation to cholera seems to be borne out by the following, from O'Connell:(1)

> These choleroid organisms are an extremely interesting phenomenon. Their relationship to true cholera may be said to have been established but not defined. Bacteriologists in service in the Far East have noted their appearance in specimens subjected to microscopical examination immediately before and during cholera epidemics. They are not known where cholera is not or has not been recently. Their morphology and biological characteristics are such that it is impossible to distinguish them from true cholera organisms by microscopic examination.

Greig,(2) working in India, has made an intensive study of these choleralike vibrios, and he classifies them according to their serological reactions with each other. He makes arbitrary division into six groups. During the past year thirty strains of nonagglutinating vibrios have been studied at the Bureau of Science. These strains were obtained from cholera cases, from carriers, and from presumably normal individuals who were contacts of cases of cholera. After obtaining a strain in pure culture, 0.1 cubic centimeter of a suspension of a twenty-four hour culture was injected into the gall bladders of a number of guinea pigs under strict asepsis. The animals were sacrificed from ten to twelve days subsequent to injection, and the contents of the gall bladder were used to inoculate peptone tubes; direct plates on Dieudonné were made also. The supply of animals being short it was decided to use bile, and transfers were made every three days. After forty such transfers eight of these previously nonagglutinable strains gave prompt agglutination in 1 to 500 dilution. Of these eight strains five held the acquired property for approximately three months. Three lost it after two months, and none held it for longer than four months. These facts were reported at the time as showing that the property of agglutination might be acquired, but my belief now is that these strains were true cholera that had lost the agglutinability.

TREATMENT

In Bilibid the carriers were given urotropin and, following Schöbl's experiments with ox bile in guinea pigs, 0.65 cubic centimeter of ox bile three times a day for two days; after an interval of five days the treatment was repeated. Those cases negative after the treatment were released from quarantine. The prison authorities at first, I believe, used sodium tauro cholate; but, the supply of this soon becoming exhausted, I suggested the use of inspissated beef bile. It was not supposed that the bile would cure the carrier condition, but that it would cause more vibrios to enter the intestinal tract from the gall bladder. The following is quoted from the Report of the Philippine Health Service for 1916:(5)

> *Results.*—From 185 cases prior to the use of ox gall, 15 or 8 per cent became repeaters within 2 months. The first ox-gall period produced the following result:
>
> Of 155 treated September 8, 9, 14 and 15, 5 were reported positive September 9, and 6 September 17; 84 of these 155 were discharged to brigades September 20, of whom 10 were returned positive on September 22; thus producing a total of 21 positives or 13.5 per cent of the 155 treated.

Of 529 prisoners receiving ox-gall treatment in the cholera brigade, 120, or 23 per cent, became repeaters. Of this number, 68, or 13 per cent, were returned as repeaters from the cholera brigade as follows:

Following first ox-gall treatment, 21 or 31 per cent.
Following second ox-gall treatment, 42 or 62 per cent.
Following third ox-gall treatment, 5 or 7 per cent.

It will be seen from this that the administration of bile would seem to be helpful in the detection of chronic carriers.

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(2) Greig, E. D. W. Bacteriological studies of cholera like vibrios isolated from stools of cholera cases in Calcutta. *Indian Journ. Med. Research* 4 (1916–1917) 658–671.

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(6) Report Sanitary Commissioner, India (1915) 62.

(7) Schöbl, Otto. Experimental cholera-carriers. *Journ. Infect. Dis.* **18** (1916) 307–314.

Idem. The relation between the amount of cholera culture injected into the gall bladder and the state of cholera carriers in experimental animals. *Philip. Journ. Sci.* § B 11 (1916) 153–155.

Idem. The influence of bile upon the duration of the state of cholera carriers in experimental animals. *Philip. Journ. Sci.* § B 11 (1916) 157 and 158.

Idem. The influence of bile upon the distribution of cholera vibrios in the digestive system of experimental cholera carriers. *Philip. Journ. Sci.* § B 12 (1917) 23 and 24.

Idem. A survey of certain chemicals with regard to their bactericidal action on cholera vibrios within the body of experimental cholera carriers. *Philip. Journ. Sci.* § B 12 (1917) 215–231.

(8) Schöbl, Otto, and Pañganiban, C. S. Experimental cholera carriers and immunity. *Philip. Journ. Sci.* § B 12 (1917) 43–49.

PHILIPPINE RAW MATERIALS FOR GLASS MAKING

By T. DAR JUAN and V. ELICAÑO

(From the Chemical Laboratory and the Division of Mines, Bureau of Science, Manila)

THREE TEXT FIGURES

Some years ago experiments were made by private concerns in the manufacture of glass from materials found in Pampanga and Tarlac, but the attempts were fruitless. At present there is a bottle factory at Santa Ana, Manila, that operates entirely with broken glass, or cullet; however, the operation of this factory is very intermittent, and its production does not meet the demand.

The imports of glass bottles and other ordinary glassware into the Philippine Islands have shown an almost constant increase since 1915, and have now reached a point where the establishment locally of a modern glass factory would appear to be justified. Information obtained by the Bureau of Science indicates that 15,000,000 split and pint bottles are used annually in the Philippines, 10,000,000 of which are returned empty to the soda-water and beer factories, leaving a probable market for not less than 5,000,000 bottles per year. Table I gives the value of Philippine imports from Japan of glass bottles, drinking glasses, and lamp chimneys for the last four years.

TABLE I.—*Philippine imports from Japan.*

[Numbers give values in pesos.]

	1918	1917	1916	1915
New empty bottles	440,090	193,093	158,419	129,197
Drinking glasses	95,057	142,076	60,268	52,859
Lamp chimneys	37,210	16,445	20,337	17,023
Total	572,357	351,614	239,024	199,079

Prices of bottles and other ordinary glassware have increased considerably during the past two years, and at present it is very difficult to secure them reasonably. In the Philippine Islands there are 12 soda-water factories (in Manila), 2 breweries, 440 drug stores, 81 alcohol distilleries, 17 repacking establishments, and a few other industries the operation of which depends entirely on the solution of the bottle problem. In view of the above considerations, we undertook this investigation in order to determine the suitability of Philippine materials for glass making.

Technically speaking, there are two general classes of glass recognized; namely, lime glass and lead glass. Lime glass is the material most commonly used for making the cheaper articles, such as ordinary bottles, demijohns, glass jars, drinking glasses, lamp chimneys, etc.; while lead glass is a more expensive product and is used chiefly in the manufacture of cut glassware and for optical purposes. The principal raw materials used in the manufacture of lime glass are lime, silica, and alkali.

LIME

Coralline and crystalline limestones of good quality occur throughout the Philippine Islands,[1] but the deposits most available to Manila are those of Montalban, Binangonan, and Tayabas. Both the Montalban and the Binangonan deposits are within the boundaries of Rizal Province; the limestone is of Miocene formation and is hard, crystalline, and of uniform chemical composition.

Montalban is located about 30 kilometers from Manila, on a line of the Manila Railroad. Binangonan is situated about 35 kilometers from Manila, with water transportation facilities via Pasig River and Laguna de Bay.

The Tayabas deposit is a metamorphosed coralline limestone and is located at Palsabangan, a barrio on the railroad and between the towns of Pagbilao and Malicboy. It is estimated that limestone may be obtained from any of these places at from 5 to 8 pesos[2] per metric ton, including cost of quarrying and transportation to Manila.

The Bureau of Science in its experimental kiln has manufactured from Montalban, Binangonan, Cebu, and Tayabas limestones over 100 tons of excellent lime, suitable for use in sugar centrals and in other industries; and there is no reason why these limestones cannot be used for glass making.

In this connection it would be of interest to note the composition of some Philippine limestones. The analyses given in Table II show that they are almost pure.

---

[1] Cox, A. J., Philip. Journ. Sci. § A 4 (1909) 211; Cox, Reibling, and Reyes, Philip. Journ. Sci. § A 7 (1912) 332.

[2] One peso Philippine currency equals 50 cents United States currency.

TABLE II.—*Analyses of some Philippine limestones.*

[Numbers give percentages.]

Constituent.	Cebu.	Binangonan, Rizal, 1912 [a]	Binangonan, Rizal, 1918.	Montalban, Rizal, 1912 [a]	Montalban, Rizal, 1918.	Palsabangan, Tayabas. [b]
Loss on ignition	43.45	43.31	43.49	43.04	43.98	43.48
Silica (SiO_2)	0.86	1.12	0.88	0.94	0.26	0.69
Iron and aluminium oxides (R_2O_3)	0.23	0.15	0.48	1.14	0.09	0.35
Lime (CaO)	54.67	53.78	54.39	54.61	54.97	54.68
Magnesia (MgO)	0.46	1.19	0.68	0.22	0.72	0.48
Alkalies (K_2O+Na_2O)		0.77		0.56		

[a] Analyzed by Forest B. Beyer. [b] Analyzed by F. D. Reyes, chemist, Bureau of Science.

SILICA

The principal source of silica is white sand or quartz. Sand deposits of good quality occur at Paracale, Camarines Province, and in the Mountain Province at Baguio; but the deposits of commercial importance are the extensive beaches of quartzose sand and the vein-quartz gravel and bowlders found in Lubang Island, Mindoro.

The quartzose sand is the result of the disintegration of the intrusive granite that outcrops on the narrow isthmus at the south end of the island, between Looc and Tabahin Bays. This sand is composed mainly of quartz, orthoclase, and mica, with variable proportions of clay.

The sand deposits are found along the southern shore of Looc Bay, from the barrio of the same name to Balacbalac Point, and along the shores of Tabahin Bay, which lies between Caybanac and Natulo Points. Each of these extends both above and below the present beach and together make an area of about 2.5 square kilometers. Between the high- and the low-water marks the sand is subjected to the constant action of the waves, with the result that a gradual concentration takes place, leaving a product of almost pure quartz. The width of the area containing the clean quartz sand averages 2.5 meters, extending throughout the length of both the Looc and Tabahin shores. From the high-water mark to the foot of the hills, which apparently at one time was a water level, the sand is mixed with greater or less quantities of clay. Below the low-water mark the sand extends into the sea about 200 meters. The probable thickness and average width of the underwater deposit is not known, as no soundings were made. The depth of the concentrated sand between the high- and the low-water marks is over a meter, and there are wells above the shore line in the vicinity of Looc that have clean sand bottoms at a depth of from 2 to 3 meters. Insufficient data are at hand to make even an approximate estimate of the total amount of sand available.

The deposits of vein-quartz gravel and bowlders are found along the coast bordering the schist and gneiss formation at the north and the south sides of the intrusive granite mentioned above. The gravel has accumulated in great quantities in all the inlets, and the supply is fairly large. The principal areas of accumulation are the northern shore of Looc Bay toward Tumbaga Point, and from Antipolo Point to Pula Point near the town of Agcauayan. It is also found on the east shore of Lubang Island from Caybanac Point to Quebrada Point, and around the southern shore from Natulo Point to Balacbalac Point. Patches of accumulated quartz gravel are also to be found on the northern shores of Golo Island from Bulacan toward Caypandan Bay. This gravel ranges in size from that of a pea to more than 75 millimeters in diameter and is mixed with quartz bowlders weighing from a few kilograms to a ton or more. The gravel and the bowlders come from the fracturing of the segregated lenticular veins of quartz found in the schist and the gneiss. Some of the quartz lenses outcropping in Dilau Point measure approximately 6 meters in thickness. However, the main supply of these quartz veins is found around Agcauayan, where several lenticular veins outcrop, and floats of quartz breccias and bowlders cover the tops of Agcauayan, Puti, and Pula Hills (see fig. 1).

Besides the materials above described, the discharge slimes from the cyanide treatment of auriferous quartz of the Colorado Mining Company cyanide mill located at Aroroy, Masbate, and other such mills, may prove to be of value as a possible source of silica in glass manufacture. The utilization of this pulp has the advantage that, being already finely pulverized, it can be mixed directly with lime and alkali without preliminary treatment. Although no actual test has been made of this material, we are of the opinion, judging from its chemical composition, that it will make a good bottle glass.

Sand of lower purity, but useful as a fluxing material in glass making, is found in large quantities at Pasay Beach, Rizal Prov-

(68)

ince, and in Tarlac River, Tarlac Province. Table III gives the analyses of silicious materials used in our experiments.

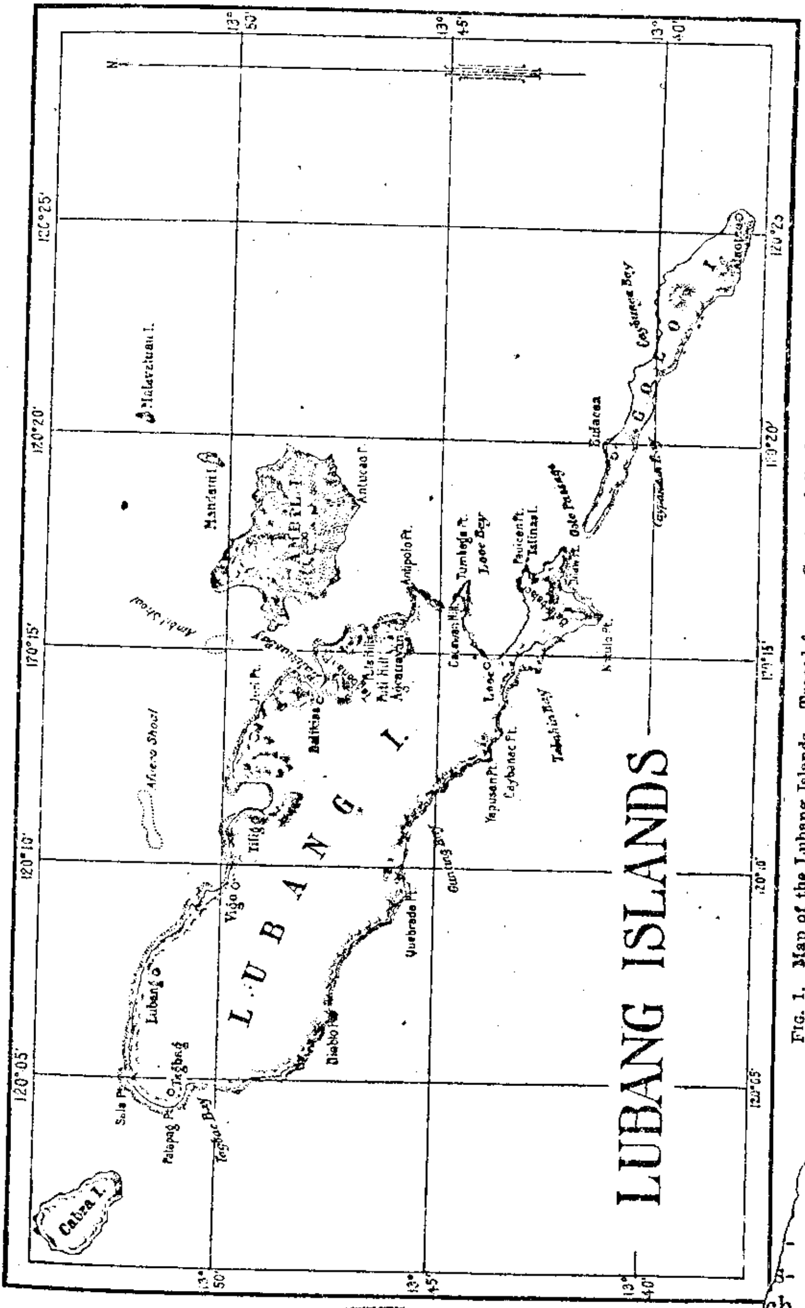


FIG. 1. Map of the Lubang Islands. Traced from a Coast and Geodetic Survey chart.

TABLE III.—*Analyses of silicious materials.*

[Numbers give percentages.]

Constituent.	Lubang quartz.	Lubang sand.	Pasay sand. [a]	Tarlac sand.	Slimes, C. M. Co. [b]
Loss on ignition	0.34	0.80	5.40	0.82	0.55
Silica (SiO_2)	97.49	86.60	56.00	57.54	84.85
Ferric oxide (Fe_2O_3)	trace	0.48	6.24	7.89	3.61
Aluminium oxide (Al_2O_3)	1.58	8.12	19.16	20.47	6.29
Lime (CaO)	trace	1.20	6.18	7.31	1.65
Magnesia (MgO)	trace	0.22	4.34	3.27	2.13
Manganese oxide (MnO_2)	trace	trace	trace	trace	----
Alkalies (K_2O+Na_2O)	0.50	[c]2.58	2.66	[c]2.70	[c]1.02

[a] Analyzed by F. Peña, chemist, Bureau of Science.

[b] Analyzed by A. S. Argüelles, chemist, Bureau of Science.

[c] Determined by difference.

ALKALI

This material is derived from sodium carbonate or sulphate, which for glass making should be as nearly free from iron as possible. Sodium carbonate, or soda ash, fuses more readily with silicious material and lime than does sulphate; but, since the latter is a cheaper product, it is more generally used in glass making, especially in the production of cheap articles. If sodium sulphate is used, some form of carbon should be admixed to assist in its reduction. Sodium carbonate and sodium sulphate, which are intermediate products in the preparation of caustic soda, depending upon the process used, may be imported from the United States or may be prepared locally from common salt. During 1917 the Philippine Islands imported 1,423,532 kilograms of caustic soda, valued at the port of origin at 326,813 pesos. The establishment in the Philippines of a caustic soda factory, in connection with a glass factory or a paper-pulp plant, will save to the Islands the value of their imports of this commodity and will encourage the exploitation in the Philippines of such industries as the manufacture of paper pulp, glass, soap, etc., all of which use caustic soda or one or more of its intermediate products as raw material. In a soda factory the largest item is fuel, and the next, common salt. It is believed that, by establishing a factory in a place where there is an ample supply of firewood, and where at the same time climatic conditions are favorable for the solar evaporation of sea water, sodium carbonate can be produced locally at approximately 102 pesos per metric ton.

In addition to the materials already described cullet is invariably used in commercial glass factories. The object of mixing cullet with the batch is to utilize the fragments of glass left over during the process of manufacture, and to serve as a flux and to lower the temperature of reaction of the materials employed. Mixing the batch with cullet also considerably reduces the cost of production. However, since the main object of this investigation was to ascertain the suitability of Philippine materials for glass making, no cullet was used in our experiments.

PROPORTIONS OF CONSTITUENTS

The proportions in which the different ingredients of glass are mixed vary considerably, depending upon the quality and composition of the raw materials available, the quantity of broken glass mixed with the batch, the temperature, and the quality and color which it is desired to give the finished product.

Table IV gives the proportions of the materials used for the different batches, the percentage composition of glass materials in the mixture, and the percentage composition of the glass obtained.

The mixtures used in the first and second batches were rather difficult to melt and gave a glass that at white heat was not sufficiently fluid to expel all the gas bubbles. If to mixture 1 a small quantity of arsenious or manganese oxide is added, as shown in the table, a practically colorless glass is obtained. Tubing and bottles made from these mixtures are hard and strong, but they become cloudy after a few weeks. Mixture 3 is not difficult to melt, the gas bubbles are easily expelled, and the glass remains perfectly transparent. Mixture 4 gives a glass practically free from bubbles, and bottles made from it have an excellent appearance. Also in this case the addition to the mixture of a small amount of arsenious or manganese oxide decolorizes the product almost completely. Mixture 5 gives a greenish glass excellent for soda-water or beer bottles. The addition of small quantities of arsenious oxide (batch 6), or of manganese oxide (batch 7), produces a lighter-colored glass. Mixture 8 gives a green glass suitable for soda-water or beer bottles, and mixtures 9 and 10, a glass rather too dark for soda-water, but good for beer and wine bottles.

The furnace used in these experiments was built after the ordinary Japanese glass pot furnace and has over-all dimensions of 188 by 79 centimeters at the base and a height of 132 centimeters. Text figs. 2 and 3 give a general idea of the furnace construction. Its most important feature is the air passage, represented in fig. 2 by the letters 1*a*, 2*a*, and 3*a*, which

TABLE IV.—*Showing composition of mixtures and glass obtained.*

RAW MIXTURE IN PARTS BY WEIGHT.

Constituent.	Batch No. 1.	Batch No. 2.	Batch No. 3.	Batch No. 4.	Batch No. 5.	Batch No. 6.	Batch No. 7.	Batch No. 8.	Batch No. 9.	Batch No. 10.
Lubang quartz	100.0	100.0	100.0	100.0						80.0
Lubang sand					100.0	100.0	100.0	80.0	50.0	
Pasay beach sand								23.0	50.0	
Tarlac sand										81.0
Sodium carbonate	32.5	32.5	35.0	54.0	40.0	40.0	40.0	37.0	35.0	88.0
Limestone	88.8	38.8	25.0	23.0						
Hydrated lime					13:0	13.0	13.0	10.0	10.0	21.0
Arsenious oxide (As_2O_3)		0.2				0.3				
Manganese oxide (MnO_2)							0.25			

PERCENTAGE OF GLASS MATERIALS IN THE MIXTURE.[a]

Constituent.	Batch No. 1.	Batch No. 2.	Batch No. 3.	Batch No. 4.	Batch No. 5.	Batch No. 6.	Batch No. 7.	Batch No. 8.	Batch No. 9.	Batch No. 10.
Silica (SiO_2)	71.51		75.00	70.52	67.60			65.63	58.87	64.31
Iron and aluminium oxides (R_2O_3)	1.15		1.18	1.16	6.75			10.07	14.05	12.51
Lime (CaO)	15.39		10.40	9.00	8.34			7.67	9.05	10.96
Magnesia (MgO)					0.17			0.93	1.88	1.37
Alkalies (K_2O+Na_2O)	11.95		13.42	19.32	17.14			16.30	16.15	10.85
Arsenic (As)										
Manganese (Mn)					trace			trace	trace	

PERCENTAGE COMPOSITION OF GLASS OBTAINED.

Silica (SiO_2)	70.14	[a]70.20	74.55	70.80	[b]66.30	67.00	------	[b]64.60	[b]60.00	64.08
Iron and aluminium oxide (R_2O_3)	1.65	1.63	2.20	1.21	7.40	7.45	------	[illegible]	[illegible]	[illegible]
Lime (CaO)	16.90	16.84	10.50	9.55	8.50	8.40	------	[illegible]	[illegible]	[illegible]
Magnesia (MgO)	------	------	------	------	0.38	0.32	------	[illegible]	1.36	[illegible]
Alkalies (K_2O+Na_2O)	11.21	11.18	12.77	18.40	[c]16.92	16.80	------	15.94	[c]15.12	9.96
Arsenic (As)	------	nil	------	------	------	nil	------			
Manganese (Mn)	------	------	------	------	trace	trace	------	trace	trace	trace

[a] Calculated from the analyses of the ingredients of the raw mixture. [b] Analyzed by F. Peña, chemist, Bureau of Science. [c] By difference.

1. Yellowish tinge. 2. Lighter than No. 1. 3. Yellowish tinge. 4. Yellowish tinge. 5. Greenish. 6. Lighter than No. 5. 7. Lighter than No. 5. 8. Green. 9. Dark green. 10. Dark green.

is built in a zigzag form below the hearth and exte the width of the furnace. From the plan it may be this furnace belongs to the gas-producer type, for the tion in the fire chamber is incomplete. The heat radia the hearth preheats the air passing through the zigza before it mixes with the hot gases in the combustion The result is that a more complete combustion of th place, and a higher temperature is obtained from around the crucible. The peep hole *c*, which is covere a sheet of mica, permits the operator to observe the temper around the crucible and also enables the removal of any that may have accumulated along the passage from the crucible chamber to the chimney. When slot *b* is obstructed, the door *d* permits the cleaning of the passage from the fire grate to the combustion chamber.

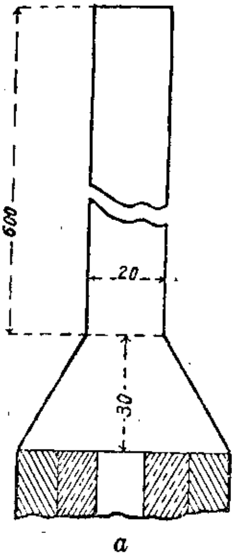
The operation of this furnace is very simple. After the fire has been started, sufficient coal is piled in the fuel chamber to fill it to the door level. The height of the fuel bed is kept at a constant level by feeding the fire chamber with 1 to 2 kilograms of coal every fifteen to twenty minutes, and occasionally cleaning the grate to avoid accumulation of cinders. If the temperature around the crucible decreases, it is an indication that the quantity of coal burning in the fire grate is insufficient; that too much or too little air is being admitted through the air passage *a* or in the fire grate; or that the passage from the crucible chamber to the chimney is obstructed with soot. This furnace gives a temperature sufficiently high to expel the gas bubbles from the molten glass and, besides being economical in fuel, has the additional advantages of simple construction and easy operation.

If a glass factory is to be established in the Philippine Islands, the following facts should be taken into consideration:

The quality and price of fuel available are as important factors as are the raw materials to be melted. At present the market price of coal in Manila varies from 40 to 50 pesos per metric ton, depending upon the quality and the market conditions. With such a high price for coal, it may prove advantageous to use coconut shells when practicable. This fuel can be obtained in commercial quantities at from 8 to 10 pesos per metric ton.

Labor is also an important factor. Glass making is a new, or practically unknown, industry in the Philippines, and naturally there are few glass blowers in the Islands. If a factory with a capacity of from five to ten thousand bottles is to be operated, it will be unwise to depend entirely upon unskilled labor. In this connection it would be advisable to investigate the capacity limits to which machine blowers can be operated economically, and to draw conclusions from the results of this investigation as to whether it would be more economical for the present to contract expert glass blowers from Japan to train Filipino laborers or to operate an automatic machine blower.

As shown by the composition and the quality of the glass, there is not the slightest doubt that the raw materials are suitable for glass making. Furthermore, in order to determine whether or not they would stand the pressure and the sudden changes of temperature to which glass bottles are subjected in a factory under ordinary working conditions, a number of glass bottles made by the Bureau of Science were tested in local soda-water factories and breweries; the results were very satisfactory.



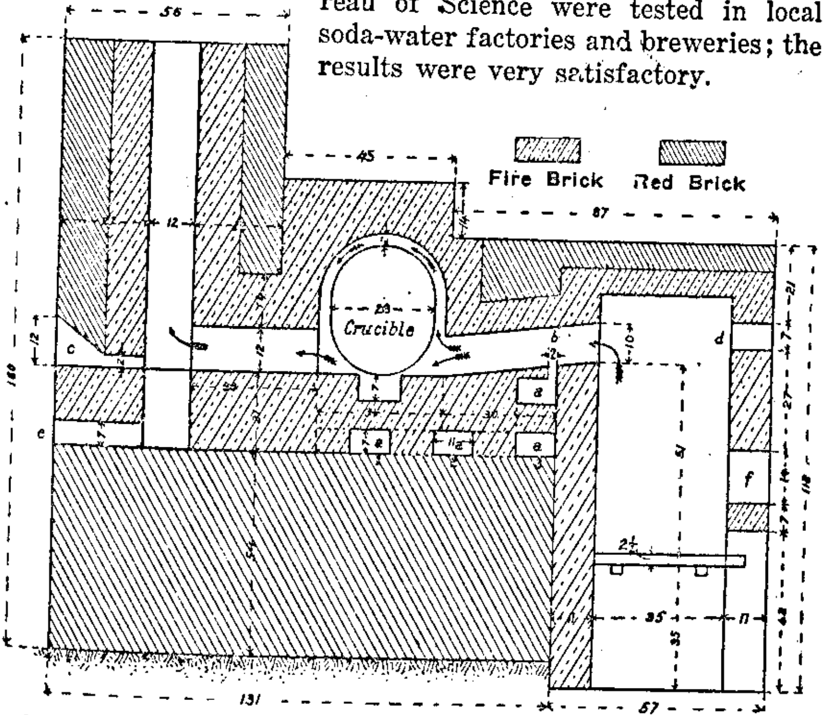


FIG. 2. Elevation of the experimental glass furnace. Section through *ABCD*. *a*, chimney, made of galvanized or plain sheet iron 1/16 inch thick.

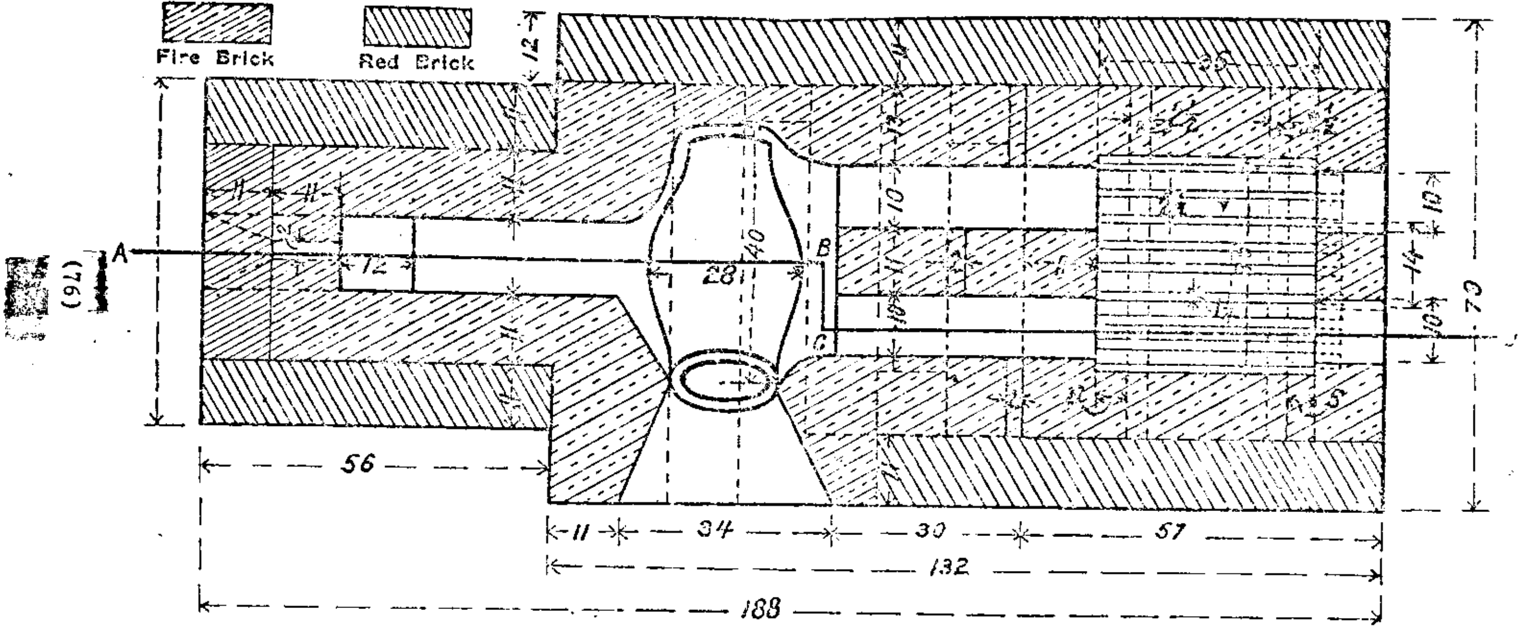


FIG. 3. Plan of the experimental glass furnace. Dimensions are given in centimeters.

In experimental tests made in the Bureau of Science, the quartzose beach sand and the vein quartz gave glass very similar in quality, except that that made from the vein quartz is of a lighter color due to a lower iron content, as shown in Table IV. The materials being of equal manufacturing suitability, the quartzose beach sand is preferable for the following reasons:

1. The quartzose sand already contains some feldspar, which lowers the melting point and supplies to the charge a certain amount of lime, alumina, and alkalies; while, if the vein quartz is used, all the fluxes have to be added.

2. The individual grains of the quartzose sand do not exceed 3 millimeters in diameter and thus, as a natural product, this sand can be readily charged into the furnaces. The vein-quartz gravel or bowlders, or the materials quarried from the veins, will necessarily have to be subjected to quenching, pulverizing, and sieving, which will increase the cost of manufacture.

3. The cost of mining sand is very much cheaper than vein quartz. The former can be readily dug from the beach and loaded into boats, while in the case of the vein quartz blasting and mucking will have to be done. The vein-quartz gravel of small size already mentioned as accumulated along the beach is not inexhaustible.

It has been stated above that a sand concentrate, averaging 2.5 meters wide and composed mainly of quartz grains, is found along the beach between high- and low-tide levels. It is considered that this supply of concentrate is inexhaustible on account of the continuous concentrating action of the waves on the adjacent deposit of impure sand, which readily and constantly supplies pure sand.

With an average width of 2.5 meters and a depth of 1 meter, extending 5 kilometers in length on both Looc and Tabahin Bays, there is ready on hand a supply of sand concentrate measuring 12,500 cubic meters. By actual test, a cubic meter of the sun-dried sand weighs approximately 1.5 metric tons. This indicates that there is available a supply of about 18,750 metric tons of sand, which will last a factory, with a daily capacity of 5 tons, twelve and one-half years of three hundred working days a year. It is presumed that after the twelfth year digging may again be done on the original place, and a concentrate be found of similar quality as before.

From data now on hand it is not possible to estimate accurately the cost of equipment for a glass factory of a given capacity, but any technical information or suggestions as to manufacture can be furnished to prospective investors.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Map of the Lubang Islands. Traced from a Coast and Geodetic Survey chart.

2. Elevation of the experimental glass furnace. Section through *ABCD*; *a*, chimney, made of galvanized or plain sheet iron $\frac{1}{16}$ inch thick. Dimensions are given in centimeters.

3. Plan of the experimental glass furnace. Dimensions are given in centimeters.

CYSTOLITHIASIS AMONG FILIPINOS IN ASSOCIATION WITH DIETETIC DEFICIENCY

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ONE TEXT FIGURE

INTRODUCTION

Osborne and Mendel(19) in their series of dietetic experiments on lower animals found an incidence of phosphatic calculi in the urinary passages of rats that had been subjected to a ration of inadequate nutritional value. In their conclusion these authors say:

> We can not offer any rigid proof of the etiologic relationship between the ration deficient in fat soluble vitamine and the formation of phosphatic calculi. The impressive statistical fact that in every case where the calculi were observed the animals had existed for some time on a diet of the sort indicated, together with our failure to discover any other pathogenic factor common to all the affected animals, makes the hypothesis suggested above worthy of serious consideration.

Following this valuable suggestion, I attempted to carry on an investigation that has practically become twofold: (1) an attempt to show as far as lay in my power the possible application of the hypothesis to a people collectively noted for an unbalanced, essentially avitamine diet such as exists in the Philippines; (2) an investigation into the chemical composition of Filipino vesical calculi, which is interesting in itself and may prove valuable, considering the relative scarcity of similar investigations in foreign countries.

The consensus among various writers who have studied the nutritional condition of the Filipino people is that a large majority of them are not receiving sufficient nourishment for the maintenance of a stable physiological activity. The recent experiments of Concepcion(8) on the nutrition of normal Filipino subjects seem to confirm this opinion.

The ordinary daily ration of the Filipino masses, consisting principally of rice which is at times so improperly prepared that most of the pericarp where the vitamines are said to exist has been removed, vegetables of moderate amount, scarcely any meat or fish, and some other dietary articles of minor importance, is as a whole deficient from a nutritional standpoint. An almost exclusively vegetarian existence, low in phosphorus and protein (Aron and Hocson(2)), or a protracted consumption of a one-sided diet may result in diseases of metabolic or nutritional deficiency, exemplified in these Islands by the existence of beriberi, the theory of dietetic deficiency as the causation of which is apparently well established by the work of Andrews,(1) Chamberlain, Vedder, and Williams,(7) Fraser and Stanton,(11) de Haan,(9) Highet,(14) Gibson,(12) Williams and Saleeby,(26) and many others.

MATERIALS AND METHODS

In the museum of the surgical department of the Philippine General Hospital there were found, at the beginning of this work, forty-eight bladder stones from Filipino subjects, some of which were intact, while others were half-cut. These had been collected from the latter half of 1914 to almost the end of 1917. The incompleteness of the clinical histories of these forty-eight cases caused some difficulty in correlating the facts in the attempt to establish a relation between the nutritional state of the patient on admission and the character of the stone surgically removed. However, during the chemical analyses of these calculi, ten cystolithiasis cases were admitted to the surgical ward during the last two months of 1917, and these were thoroughly examined from a nutritional standpoint. Therefore, the present investigation is based on fifty-eight cases of vesical calculi with a view to correlating as far as practicable the clinical data with the chemical composition of the different layers of the individual stones.

To present a picture of the nutritional condition of the patients, it was planned to collect and condense all the essential points in the clinical-history record of the cases. All of the patients were Filipinos, of different age, sex, social condition, occupation, etc.—all of which factors must be considered in determining the relative frequency, and in tracing the nutritional etiology, of the disorder in each group. It must be emphasized that, except for the last ten cases, the history of beriberi as a whole was unreliable. Fortunately, however, most of the hospital records show, from objective examination of the patients, the degree of their body development and nutrition. The importance of considering the associated diseases, including intestinal parasitic infestation, lies in the fact that they tend to decrease the vital resistance of the body to the development of superimposing maladies. Diseases of the genito-urinary tract have been included in the case records to aid in explaining the formation of calculi. Whenever autopsy was performed on any of the cases, attempt was made to note the anatomical diagnosis for possible evidences of beriberi. Urine examinations have been made in most of the patients.

After weighing the stones, they were cut with a fine saw into two approximately equal parts, one of which was utilized in the analysis, while the other remained in the museum for further reference or subsequent study. Those that were cut were again divided into two, thus making the analyzed portion about one-fourth of the original stone. The layers of the portion analyzed were peeled off and weighed individually. Having determined by proportion the weight of the individual layers in toto, based on the weight of the whole or of half of the stone and that of the analyzed portion of the layer, the latter was subjected to a qualitative chemical analysis according to Heller's scheme.

Experience showed that the chemical phenomena were sometimes so misleading that the interpretation of results did not in some instances approach the desired accuracy. To check this error, I adopted the following modification in the analysis of each layer: The layer was ground to a powder and a small amount of the powder was dissolved by the aid of gentle heat in dilute hydrochloric acid; after filtering the solution, two drops of the filtrate were put on a slide and subjected to the action of ammonia vapor beneath a shallow glass container; about fifteen or twenty minutes were allowed for the reaction, and the crystals or sediments formed were examined and identified under the microscope.

In case of multiple calculi, the largest was weighed and analyzed in the same manner. The smaller ones were also cut and analyzed, but not recorded. The weight of the largest stone and that of the individual layers were calculated, as it was intended to determine or compute as far as practicable the rate of growth.

As a whole, the patients on admission were in a state of relatively low vitality, which is shown by the prolonged recovery after operation in the majority of the cases, sometimes three months as in case 25. Eleven of the cases gave a positive history or signs (or both) of beriberi. Eighteen were undernourished individuals with an unreliable history of beriberi, all of which belong to the first group of my clinical cases where the data were taken with very little or no stress on the nutritional bearing of the disease. Twenty-three of the series were determined as well-developed and well-nourished individuals, all of which except one pertain to the first group above mentioned. The rest of the cases (six in number) received no mention as to their nutritional condition. For the sake of clearness, the series may be divided into four groups as follows: I, cases which gave positive signs of beriberi; II, cases which indicated no reliable history of beriberi, but which were undernourished and belonged to the poorer class; III, cases which were well developed and nourished; and IV, cases regarding whose nutritional condition we have no data.

FINDINGS AND DISCUSSION

The fifty-eight cases studied, with their short clinical histories and the qualitative chemical analyses of their respective calculi, are too long for publication in full in this paper. Examples of the condensed case histories and chemical findings in only four cases, each representing a group, are given to show how the data were arranged for presentation in tabular form.

CASE 53 (GROUP I)

E. M. (55787), 25 years old, married, male, Filipino, fisherman; born and living in Taliptip, Bulacan, Bulacan; admitted to the hospital November 26, 1917, complaining of painful, frequent, and at times bloody urination of about one year's standing. Had measles while young, cholera at 10 years of age, and several attacks of rheumatic fever. Denies venereal diseases. He is well developed but poorly nourished. Signs of beriberi present and history of having had the disease is positive.

Clinical diagnosis.—Cystolithiasis, pulmonary tuberculosis, and trichuriasis.

Urine examination.—Reaction, slightly alkaline; sugar, negative; albumin, marked trace; microscopic, abundant red cells, occasionally casts, pus cells, and some squamous epithelial cells.

Cystolithotomy was performed November 30, 1917, and the patient died a few days afterward.

Calculus analysis (one yellowish stone).

	Grams.
Whole stone	26.5
Portion analyzed	14.0
First and second layers (inseparable)	6.0
Third and fourth layers (inseparable)	5.0
Fifth layer	2.0
Nucleus	1.0

Weight by proportion.

	Grams.
Cortex and second layer (inseparable)	11.4
Third and fourth layers (inseparable)	9.4
Fifth layer	3.8
Nucleus	1.9

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex and second layer	Amorphous and triple phosphate.	Calcium carbonate and trace of calcium oxalate.
Third and fourth layers	Amorphous phosphate	Calcium oxalate, calcium carbonate, and ammonium urate.
Fifth layer	Amorphous phosphate	Do.
Nucleus	Calcium oxalate	Amorphous phosphate and trace of uric acid.

CASE 9 (GROUP II)

E. M. (37388), 13 years old, single, female, Filipino, student; born and living in Santo Tomas, Batangas; admitted to hospital July 26, 1915, complaining of painful, frequent, difficult, and scanty micturition, and pus discharge occasionally. The condition is of about six years standing. No history of past diseases nor of beriberi. She is moderately developed but poorly nourished.

Clinical diagnosis.—Cystolithiasis, chronic cystitis, and prolapse of the rectum.

Urine analysis.—Reaction, alkaline; sugar, negative; albumin, a decided trace. Microscopic, abundant pus cells, some blood and mucus.

Cystolithotomy was performed August 3, 1915; the patient was discharged September 2, 1915.

Calculus analysis (one white irregular stone).

	Grams.
Whole calculus	31.5
Portion analyzed	15.1
Cortex, analyzed portion	5.5
Second layer	5.2
Third layer	4.0
Nucleus	0.4

Weight by calculation.

	Grams.
Whole cortex	11.5
Whole second layer	10.9
Whole third layer	8.3
Whole nucleus	0.8

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex	Triple and amorphous phosphate.	Calcium carbonate and ammonium urate.
Second layer (brownish white).	Amorphous phosphate and uric acid.	Ammonium urate and cystine.
Third layer (brown)	Calcium oxalate	Amorphous and triple phosphate.
Nucleus	Triple and amorphous phosphate.	Uric acid, ammonium urate, and calcium sulphate.

CASE 23 (GROUP III)

E. G. (44226), 26 years old, married, male, Filipino, laborer; born and living in Quingua, Bulacan; admitted to the hospital June 19, 1916, complaining of frequent and bloody urination of about one year's standing. He had fever of short duration during childhood and frequent attacks of malaria at the age of 15 years. He is well developed and nourished. No history of beriberi.

Clinical diagnosis.—Cystolithiasis, trichuriasis, and ankylostomiasis.

Urine examination.—Reaction, acid; sugar, negative; albumin, abundant; microscopic, very abundant pus.

Cystolithotomy was performed June 20, 1916. The patient was discharged fourteen days after the operation.

Calculus analysis (one yellow stone).

	Grams.
Whole calculus	97.0
Portion analyzed	43.6
Cortex, or first layer, analyzed	37.2
Second, third, fourth, and fifth layers (inseparable)	5.3
Sixth layer, analyzed	0.9
Seventh layer, or nucleus	0.2

Weight by proportion.

	Grams.
Whole cortex	82.8
Whole second, third, fourth, and fifth layers	11.8
Whole sixth layer	2.00
Whole seventh layer, or nucleus	0.4

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex of first layer (brownish).	Uric acid	Calcium oxalate.
Second layer (reddish)	do	Do.
Third layer (dark red)	Calcium oxalate	Uric acid.
Fourth layer (whitish)		
Fifth layer (dark red)		
Sixth layer (brownish)	Uric acid	Calcium oxalate.
Nucleus (dark red)	do	Some calcium oxalate.

CASE 31 (GROUP IV)

B. D. (47613), 4 years old, Filipino boy; born and living in Tondo, Manila; admitted to the hospital December 27, 1916, complaining of difficult and painful urination of about one month's standing. History of past illness and of beriberi unreliable. Nutritional condition undetermined.

Clinical diagnosis.—Cystolithiasis and acute abscess of abdominal wall.

Urine examination.—Reaction, alkaline; sugar, negative; albumin, an appreciable trace. Microscopic, numerous erythrocytes and a few degenerated epithelial cells.

Cystolithotomy was performed December 29, 1916, and the patient was discharged February 11, 1917.

Calculus analysis (one dull whitish stone).

	Grams.
Whole stone	5.5
Portion analyzed	2.0
Cortex analyzed	0.9
Medullary layer analyzed	0.8
Nucleus analyzed	0.3

Weight by proportion.

	Grams.
Whole cortex	2.5
Whole medullary layer	2.2
Whole nucleus	0.8

Composition of layers.

Layer.	Constituent.	
	Chief.	Minor.
Cortex	Amorphous phosphate and calcium carbonate.	Calcium oxalate and trace of ammonium urate.
Medullary layer	Calcium carbonate	Amorphous phosphate, calcium oxalate, and ammonium urate.
Nucleus	do	Calcium oxalate, ammonium urate, and amorphous phosphate.

The analysis of each layer of an individual calculus is given as each may be regarded as a distinct stone formation. It should be recalled that a stone is formed, in the presence of a binding substance, around a nucleus, which may be a mass resulting from an inflammatory process of the vesical mucosa (pus, blood, or bits of necrotic tissue), or foreign bodies such as fragments of bougies, pins, silk sutures, or a previously formed stone which may have come from the kidney, or one that has been formed earlier in the bladder around which other layers of stone are formed with the same or different chemical composition.

The disposition of the bladder calculus in layers of different chemical substances may be the result of a change in the composition of urine secondary to a modified general metabolic process. Sondern,(22) in speaking of the increase of the calculus in size, says that—

> The abnormal condition during which the nucleus is found may be temporary and that the stone can continue to grow in size even if normal urine is excreted.

Once the nucleus of stone is formed around a mass of "foreign body" coated by the binding substance or albuminoid framework, the tendency is toward a more or less continuous deposit of practically the same chemical substances in almost the same proportions as in the original primary stone. It is possible that with the decline of health, usually secondary to faulty metabolism and nutrition, unfavorable fermentative changes may take place inside the bladder, which may subsequently give rise to the formation of a second layer of stone of distinct chemical composition, thereby making the primary calculus the nucleus of the second stone which Wells(25) considers a secondary calculus. Because of the injury produced by the resulting calculus, the condition may aggravate or the disease and general nutrition may improve as a result of treatment. In either case, a third layer of stone is formed with different chemical composition around the two-layered already existing calculus as a nucleus. This last layer may be considered as a third stone formation. Incidentally the analysis of several cases of multiple calculi removed (as in case 25) show that the medullary layer—that is, the layer outside of the nucleus—of the larger one is chemically almost indentical with the nucleus of the two-layered smaller one and the cortices, or the outside layers, of both are similar, as indicated in fig. 1. It is apparent that the first stone formation (primary stone) of *b* took place simultaneously with the second layer of *a* and that the two-layered calculus of *a* acted as a nucleus of the third layer, thus playing the rôle of the primary stone of *b*. Consequently, for a given stone there are as many stone formations as there are layers, which may or may not be physically and chemically distinct from one another.

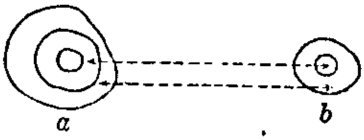

FIG. 1. Two- and three-layer calculi.

From the fifty-eight cases examined there have been made out one hundred eighty-nine different layers or stone formations, the compositions of which are given in the following tables. In instances of multiple calculi the chemical composition of the largest stone is the only one considered.

In the beriberi cases, Group I, thirty-six layers, 66.67 per cent, were chiefly phosphatic; and in those cases, Group II, having histories of poor nutritional condition fifty-nine layers, 72.88 per cent, were phosphatic. In the group of well-nourished individuals, Group III, seventy-six layers, there were 40.79 per cent of uric acid and urates, against 36.84 per cent of chiefly phosphatic layers. In Group IV, where the nutritional condition was not noted in the clinical record, the incidence of phosphatic composition is also higher (nine layers or 50 per cent phosphate) against five layers or 27.77 per cent of uratic concretions.

TABLE I.—*Percentage of incidence of the chief constituents of the different layers.*

Chief constituents.	Group I.		Group II.		Group III.		Group IV.		Total.	
	Layers.	Incidence.	Layers.	Incidence.	Layers.	Incidence.	Layers.	Incidence.	Layers.	Incidence.
		Per cent.		*Per cent.*		*Per cent.*		*Per cent.*		*Per cent.*
Phosphates (amorphous, triple, and calcium)	24	66.67	43	72.88	28	36.84	9	50.00	104	55.03
Urates (uric acid and ammonium urate)	8	22.22	10	16.95	31	40.79	5	27.77	54	28.57
Oxalate (calcium)	2	5.56	4	6.78	12	15.79	1	5.56	19	10.05
Carbonate (calcium)	2	5.55	1	1.70	2	2.63	2	11.11	7	3.70
Mixed (phosphate and urate, phosphate and oxalate, phosphate and carbonate)	----	----	1	1.69	3	3.95	1	5.56	5	2.65
Total	36	----	59	----	76	----	18	----	189	100.00

TABLE II.—*Incidence of chief constituents in nuclei.*

Chief constituents.	Group I.		Group II.		Group III.		Group IV.		Total.	
	Number.	Incidence.	Number.	Incidence.	Number.	Incidence.	Number.	Incidence.	Number.	Incidence.
		Per cent.		*Per cent.*		*Per cent.*		*Per cent.*		*Per cent.*
Phosphate	5	45.4	13	72.2	7	30.4	2	33.3	27	44.6
Urates	3	27.2	3	16.7	10	43.5	2	33.3	18	31.0
Oxalates	2	18.2	1	5.55	4	17.4	1	16.7	8	13.8
Carbonates	1	9.1	1	5.55	2	8.7	1	16.7	5	8.6
Total	11	100	18	100	23	100	6	100	58	100

The totals for one hundred eighty-nine layers show one hundred four layers or 55.03 per cent with phosphates as the chief constituents, and fifty-four layers or 28.57 per cent of chiefly uratic composition. Oxalates occurred as chief constituents in nineteen or 10.05 per cent of the layers, carbonates in seven or 3.7 per cent, and there were five layers or 2.65 per cent with mixed phosphate and urate, phosphate and oxalate, and phosphate and carbonate as the chief constituents. Table II shows the chief constituents of the primary stones.

The percentage of primary phosphatic calculi is greatest in the individuals belonging to Groups I and II, in whom the nutritional condition was below par. In Group III, where the percentage of urates predominates, the affected individuals belong to a class with adequate food supply.

These findings are not in accord with the findings of foreign investigators. Wells(25) and others say that urate calculi exceed the rest in frequency. Ultzmann(24) found that out of five hundred forty-five cases of primary calculi 80.9 per cent were with nuclei consisting of uric acid (and urates), 5.6 per cent of calcium oxalate, 8.6 per cent of earthy phosphate, 1.4 per cent of cystin, and 3.3 per cent of some foreign body. Gordon's(13) statistics on his investigation of one hundred calculi which give a predominance of uratic stone in England may here again be recalled. Reed(20) reports a case in which the calculus was composed of urate and concentric rings of calcium oxalate with a colloid nucleus. Kahn and Rosenbloom(15) have analyzed a number of urinary calculi and in their conclusion they state:

> 1. The large majority of renal stones are composed of oxalate of lime.
> 2. Uric acid and the urates are found in all renal concretions, but it is rare to find a renal calculus that is mainly composed of the urates.

These same authors present analyses of two vesical calculi and both were made up almost exclusively of uric acid. Lastly Spiegel,(23) in an analysis of a large number of urinary stones, both renal and vesical, finds that only twenty of fifty stone formations contain phosphates, even as a minor constituent.

Oxalate stones which, according to Gordon and to Cabot,(6) may be derived from oxalate-containing vegetable foods, such as rhubarb and sorrel, are not common among Filipinos. While Spiegel and others believe that calcium carbonate calculi may originate from the excessive use of hard water (as is the common well water of the Islands), such stone formations are infrequent in this series. I have not found xanthine, urostealith, or fibrin calculi, which are occasionally mentioned in the literature.

An inference might be drawn from comparison of my findings among Filipinos with those among Caucasians. The association of phosphatic calculi in the cases here classified as undernourished (with an unbalanced diet), and the frequency of urate stones among a class of people with nourishment sufficient for normal physiological processes are points that strongly agree with the incidental findings of Osborne and Mendel(19) in their experiments upon animals. As a whole, the total phosphatic estimates give an incidence of more than half of the total number of calculi among Filipinos. It is possible that quite a number of the cases at hand, although suffering from the so-called latent form of beriberi or other nutritional-deficiency disease, did not give any history nor present any suspicious sign of the disease at the time of admission, and in many instances the malady may have been entirely overlooked (Manalang,(17) Saleeby(21)). All but one of my cases (cases 49 to 58, Group I) gave a positive history of having had beriberi, and in this particular case the stone was essentially oxalate in composition. In only two of the beriberi cases were the calculi made up mainly of urates, and therefore the percentage of phosphatic stone formations in association with this disease is greatest.

The character of the stone deposit is partly dependent upon the influence of the urine reaction. Thus Ballenger and Elder,(3) in speaking of the cementing substance that holds the crystals together to form the calculus, say:

> This doubtless varies with different stones according to the acidity or alkalinity of the urine. Stones composed of uric acid, urates, calcium oxalate, cystin and xanthin develop in acid urine while those consisting of calcium carbonate and acid phosphate of calcium arise in alkaline urine. Stones of ammonium or magnesium phosphate are precipitated from stagnant urine with local infection and inflammation.

Spiegel, in his series of chemical analyses, has corroborated this fact. Kahn and Rosenbloom, however, slightly differ from this view. These authors state:

> While uric acid and acid salts are soluble in alkaline medium and insoluble in acids, the exact opposite holds good for calcium oxalate and calcium phosphate, which are deposited in alkaline medium and dissolved in acids.

Blatherwick(4) says:

> High urinary acidity favors the formation of uric acid calculi, which comprise from 60 to 81 per cent of all urinary concrements.

Wells states that:

> "Phosphate calculi are formed as a result of decomposition of the urine, with the formation of ammonia from the urea. In the ammoniacal solution

thus formed the magnesium is precipitated as NH_4MgPO_4, the calcium as $Ca_3(PO_4)_2$ and calcium oxalate and ammonium urate are also thrown down, so that the concretions consist of a mixture of these substances, the magnesium salts being the most abundant." He then goes on to say that "the formation of phosphatic concretions is always a matter of urinary reaction and not of diet."

Due to lack of data as to the reaction of the urines before the onset of the disease, the present urine examinations are to be correlated with the chemical composition of the cortex or outside layer of the stones. In my series there are cases of alkaline urine where the stone is covered with uric acid or urate cortex. The latter phenomenon may be explained by the presence of inorganic phosphates, or by the fact that the alkaline fermentation has not yet been brought to completeness. The opposite condition may be true with the phosphate or carbonate stone in an acid medium. The neutral urine, on the other hand, may be a transitional stage in the process of ammoniacal fermentation in the urine brought about by infection, or may result from the so-called "alkaline tide." That food influences the reaction of the urine is shown by Blatherwick, who states:

> In general, foods yielding an alkaline ash were found to decrease urinary acidity, while those yielding an acid residue increased it.

The urine of Filipinos is normally less acid than that of Americans or Europeans, owing chiefly to the low protein content of their diet, which consists chiefly of rice and a little fish among the poorer classes. The reaction of the urine from the cases on admission to the hospital may be compared with the composition of the cortices of the calculi in forty-nine cases of the series. Thus there were found in acid urines nine phosphate and nine urate or uric-acid cortices and one oxalate cortex; in alkaline or neutral urines, there were twenty-three phosphate and four uric-acid or urate cortices, one oxalate cortex, and one oxalate and phosphate cortex. The results show a tendency toward the formation of phosphate concretions in neutral or alkaline urines in accord with the literature.

Taking the composition of the nuclei of the stones for comparative reference in regard to the age when the first symptoms of cystolithiasis developed (which may not coincide with the exact date of the beginning of the formation of the urinary stone), we have Table IV.

We notice that among these fifty-eight cases there was a greater incidence of stone formation in children and young adults, contrary to the opinion of Bugbee,(5) who found a greater frequency of vesical calculi among patients past middle life. It is also to be noted that in the first four decades, and even among the undetermined cases, except one who is more than 50 years of age, the phosphatic calculi take the lead, while in the fifth and sixth decades of life, the urates predominate. This finding is contrary to that of Cabot who states that uric acid and calcium oxalate are often found in the urine of poorly nourished children due to imperfect oxidation of the tissues, and of old individuals who take food beyond their power of assimilation. Also Ellinger (10) considers stone in children to be almost always uratic in composition.

TABLE IV.—*Age incidence with reference to the composition of the nuclei.*

Chief constituents.	Age in years.						
	1 to 14.	14 to 20.	21 to 30.	31 to 40.	41 to 50.	51 to 60.	61 to 70.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Phosphates	52.9	100	35.3	50	66.7	20	
Urates	29.4		23.5	16.7	16.7	80	100
Oxalates			35.3	16.7	16.6		
Carbonates	17.7		5.9	16.6			
Total (cases)	17	1	17	6	6	5	2

Chief constituents.	Undetermined	Total.
	Per cent.	*Per cent.*
Phosphates	75	46.6
Urates	25	31.0
Oxalates		13.8
Carbonates		8.6
Total (cases)	4	58

The occupation of the patient at the time when the stone was removed may have a bearing on the composition of the latest stone formation, which is the cortical layer. Table V gives an idea of the chief constituents of cortex with reference to the latest occupation of the patient.

It is noticed that stone formation is of more frequent occurrence among ordinary laborers and farmers; and in all branches of occupation the phosphatic calculi are most frequent in incidence. Concepcion has pointed out the insufficiency of the earnings of the average unskilled laborer for the proper maintenance of a family under sanitary conditions. The general poverty of the laboring class naturally predisposes them to nutritional disorders. As a rule farmers are vegetarians, and their circumstances of living are such that they consume very little or no

TABLE V.—*Incidence of chief constituents of cortex of calculus as related to present occupation.*

Chief constituents.	Laborers.	Farmers.	Boys without occupation.	Students.	Miscellaneous.[a]	Total.
Phosphates	8	10	6	4	10	38
Urates	7	4		1	3	15
Oxalates	1	1		1		3
Phosphates and oxalates	1					1
Phosphates and carbonates			1			1
Total	17	15	7	6	13	58

[a] Carpenters, sellers, plumbers, fishermen, etc.

meat. Boys without occupation would naturally be dependent on the earnings of their parents, whose income is, in many instances, not sufficient for the maintenance of a normal physiological existence. Students in the public schools who come from the average family do not as a rule receive enough allowance to provide them with a wholesome and nutritious food on account of the high cost of living in the city. The remaining cases (included under miscellaneous) belong to a class of occupations with relatively low earnings and consequent low standard of living and probable deficiency in nutrition.

The distribution of cystolithiasis may be of some value in tracing the nutritional relations, particularly of the phosphatic calculi. Foreign authors attribute the irregularity of distribution to the habits of the people, their mode of living, selection of food and drink, and climatic conditions (Morton(18)). This investigator in his clinical lecture delivered at the Long Island College Hospital pointed out the prevalence in India of stones that are primarily uratic, infiltrated with oxalates and triple phosphates, and only found among the legumen eaters. Gordon also found a predominance of uratic stones in England, and says: "It has been attributed, we think erroneously to eating meats." The same author attributes the prevalence of stone in Holland to the hard-water supply, contrary to the opinion of Lewis(16) who maintains that:

> The problem of oxalurics is not to prevent the introduction of calcium salts but the absorption of exogenous oxalic acid in the foodstuffs.

In the Philippines the phosphate stones predominate in almost all of the provinces concerned except Pampanga. Table VI gives this incidence, and the character of the stone here is determined by the chemical composition of the cortex, as this may be affected by the regional conditions under which the patient was living at the time immediately previous to the removal of the stone.

TABLE VI.—*Number of cases of cystolithiasis by provinces and by constituents of the stones.*

Province.	Phosphate.	Urate.	Oxalate.	Phosphorus oxalate.	Phosphorus carbonate.	Total.
Bataan	1					1
Batangas	7	2				9
Bulacan	6	3	1			10
Cavite	2	2				4
Laguna	2					2
La Union	1					1
Manila	4	1			1	6
Nueva Ecija	4		1			5
Pampanga	3	4		1		8
Pangasinan	1		1			2
Rizal	4	2				6
Tayabas	1	1				2
Zambales	2					2

The social condition and sex may here be disregarded because they would not have any influence in changing the dietetic condition of the patient.

SUMMARY AND CONCLUSIONS

The observations of Osborne and Mendel on rats indicate a possible association of dietetic deficiency with the formation of phosphatic urinary calculi. The Filipino diet is essentially of an insufficient and limited character, particularly in its vitamine content. Beriberi is still frequently encountered in these Islands, and Saleeby and others have indicated the frequency of the disease in a latent form which, with further limitation in diet, may become active and widespread. My personal experience in the Philippine General Hospital confirms this view. The results of the present investigation show that a relation apparently exists between the general dietetic inadequacy and deficiency among Filipinos and the incidence of phosphatic calculi, in contrast with the reported predominance of uric acid and urate calculi in Europe and the United States.

Of ten cases of cystolithiasis which I have particularly studied since this investigation was undertaken, nine not only gave a history of having had beriberi, but exhibited actual signs referable to the disease. Although the clinical data of all but two of the other forty-eight cases are, as a whole, obscure with respect to the history of nutritional disease, still they indicate that the majority of the patients were undernourished and underdeveloped. It is probable that among these forty-eight cases, there were many, besides the two, who were beriberic either in active or latent form, as the symptoms of beriberi were not especially looked for in preparation of their clinical histories from a purely surgical standpoint.

The cases studied have been classified into four groups; (I) eleven cases, nine of which were my own, giving positive history or signs of beriberi; (II) eighteen cases with an unreliable history of beriberi, but undernourished and from the poorer class; (III) twenty-three well-nourished and well-developed individuals; and (IV) six cases of uncertain nutritional condition.

The percentage of primary phosphatic calculi (nuclei), as determined by qualitative tests, is greatest in the individuals belonging to groups I and II, being 45.4 and 72.2, respectively. Primary urate calculi were most frequently found in the well-nourished cases (group III), occurring in 43.5 per cent of these cases.

Of the one hundred eighty-nine layers from fifty-eight stones examined, one hundred four layers or 55.03 per cent were phosphatic in composition; fifty-four or 28.57 per cent, uratic; nineteen or 10.05 per cent, oxalates; seven or 3.70 per cent, carbonates; five or 2.65 per cent, mixed phosphate and urate, phosphate and oxalate, and phosphate and carbonate.

A majority of the cases occurred in children and young adults. Uric acid or urate nuclei were found in six out of eight cases over 50 years of age, while phosphates predominated in the earlier decades.

The classification of the cases as regards occupation indicates the prevalence of stone formation chiefly among laborers and farmers. The provincial distribution of the cases is as follows: Bulacan, 10; Batangas, 9; Pampanga, 8; Rizal, 6; Manila, 6; Nueva Ecija, 5; Cavite, 4; other provinces, 10. Phosphate cortices predominated in all occupations and in all the provinces except Pampanga.

Among forty-nine cases the chief constituent of the cortices was phosphate in twenty-four cases, with a neutral or alkaline urine, and in nine cases with an acid urine. The reaction of Filipino urine is normally acid, but to a less degree than in the United States and Europe because of the low protein intake.

It is apparent, therefore, that the inadequate dietetic conditions among Filipinos and concomitant nutritional disorders such as beriberi favor the formation of phosphatic stones, owing to the low daily protein intake and the lessened acidity of the urine resulting therefrom.

I wish to extend my profound gratitude to Dr. Potenciano Guázon, chief of the department of surgery, College of Medicine and Surgery, University of the Philippines, for the exceptional opportunities he has given me to utilize the stones in the museum of the operating room of the Philippine General Hospital for chemical analysis. To Prof. Bowman Corning Crowell, chief of the department of pathology and bacteriology, University of the Philippines, I express my sincere appreciation for his strong encouragement in the present study. I acknowledge the valuable coöperation of my colleague, Doctor Aguilar, who has many times taken my place when on duty in the hospital. But above all, I wish to express my due acknowledgment and most hearty appreciation to Prof. Robert Banks Gibson, chief of the department of physiology, University of the Philippines, for his suggestions and priceless help in the preparation of this paper.

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ILLUSTRATION

TEXT FIGURE

FIG. 1. Diagrammatic representation of two- and three-layer calculi.

THE GROWTH OF HEVEA BRASILIENSIS IN THE PHILIPPINE ISLANDS

By Harry S. Yates

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila)

ONE TEXT FIGURE

Probably no agricultural industry within the Tropics has undergone so remarkable a development during the past twenty years as has the plantation-rubber industry. *Hevea brasiliensis*, the principal source of plantation rubber, was first grown under cultivation when it was introduced into Ceylon about 1877.[1] Very little further planting was done until the experimental stage was passed and seed became available in quantity. The beginning of the cultivation of *Hevea* in Ceylon may be said to date from about 1890 to 1895 though for the first ten years development was comparatively slow. In Malaya *Hevea* attracted very little attention until about 1897, when, coffee becoming less profitable, planters saw the need of some product to supplement or replace it. However, when the Malayan planters did turn their attention to rubber, the development of the industry, stimulated by the high price prevailing for the product, took place very rapidly; and at present Malaya produces a very large share of the plantation rubber of the world. The cultivation of *Hevea* having proved successful and profitable in Ceylon and Malaya, many plantations have been started in other countries; more especially in Sumatra, Java, Borneo, India, Burma, Cochin China, New Guinea, and other places in the Asiatic Tropics, the Gold Coast and elsewhere in Africa, and in various parts of tropical America. The area planted to rubber in Malaya alone up to and including 1916 was 385,372 hectares (951,870 acres),[2] while the total area planted to rubber in the

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[1] Those interested in an account of the early development of the industry are referred to Petch, Notes on the history of the plantation rubber industry of the East, *Ann. Roy. Bot. Gard. Peradeniya* 5 (1914) 433–520; and Burkill, The treatment to which the Para rubber trees of the botanic gardens, Singapore, have been subjected, *Gardens' Bull.* 1 (1915) 247–295.

[2] India Rubber Journ. No. 13, 55 (1918) 10.

Dutch East Indies in 1916 has been estimated at 209,312 hectares (517,000 acres).[3]

Although the United States takes considerably more than one-half[4] of the world's supply of crude rubber, very little is produced in American territory. Unmanufactured India rubber imported into the United States during the year ending December 31, 1917, amounted to 184,381,035 kilograms (405,638,278 pounds),[5] valued at 466,441,808 pesos. It is true that a part of this was wild rubber from South America, Africa, and elsewhere; but the imports of crude rubber in 1917 from the British and Dutch East Indies alone amounted to 115,915,868 kilograms (255,014,910 pounds), valued at 300,303,192 pesos. In view of this very large importation of rubber into the United States and the importance of the industries there dependent upon it, it would seem very desirable to develop a rubber-planting industry within American territory should land and climatic conditions suitable for the successful growth of *Hevea brasiliensis* be found.

There has long been a question as to the suitability of certain sections of the Philippines for the growth of *Hevea brasiliensis,* but notwithstanding its remarkable development in nearby countries the industry has received very little attention here. However, a small area of *Hevea brasiliensis* has been planted and is now producing rubber in profitable quantities; and, while it must be admitted that the industry has hardly passed the experimental stage, it has been demonstrated that rubber will grow and yield satisfactory returns in the Philippine Islands.

During the latter part of 1917 I had the opportunity of visiting the Basilan Plantation Company's estate on Basilan Island and while there made a number of girth measurments of trees of various ages. The results of these measurements are given in the present paper together with data regarding the climatic and soil conditions in the southern part of the Philippine Archipelago. The rate of growth of *Hevea brasiliensis* in the Philippines is compared with that recorded in other countries, and a comparison is made of the climatic conditions and soils of this part of the Philippine Archipelago with those in other countries, more especially in the Orient, where Para rubber is now being successfully cultivated.

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[3] India Rubber World 54 (1916) 382.

[4] The India Rubber Journal No. 19, 55 (1918) 10 quotes a statement that in 1917 the United States took 71 per cent of the entire crude-rubber production of the world.

[5] India Rubber World 57 (1918) 384.

CLIMATIC CONDITIONS SUITABLE FOR THE GROWTH OF HEVEA

The original home of *Hevea brasiliensis* is in tropical South America along the Amazon and its tributaries, a region having a moist warm climate, and a fairly uniform distribution of rainfall. Meteorological data from the observatory at Belem (Para), located near the coast and slightly south of the mouth of the Amazon, indicate a climate with a rainfall averaging about 2,500 millimeters fairly evenly distributed throughout the year, though with a dryer season during September, October, and November. The temperature appears to be fairly uniform during the year; it averages about 25° C., and rarely falls below 20° C. or rises above 37° C. The distribution of rainfall by months and the number of rainy days in each month at Para are shown in Table I.

TABLE I.—*Rainfall at Belem (Para), State of Para, Brazil.*[a]

[Rainfall is given in millimeters.]

Month.	1907		1909		1910	
	Rainfall.	Days.	Rainfall.	Days.	Rainfall.	Days.
January	208.9	27	295.8	24	262.4	30
February	361.4	27	387.2	25	253.0	25
March	234.3	30	219.3	27	404.5	31
April	174.6	27	349.4	25	246.5	27
May	283.7	28	252.5	27	275.8	23
June	242.7	26	132.5	22	333.0	23
July	178.8	24	138.4	14	252.5	19
August	133.8	17	117.5	10	153.4	22
September	81.8	23	89.9	21	101.1	22
October	67.3	15	93.1	21	76.6	22
November	110.6	22	89.5	18	82.5	22
December	260.1	22	163.2	16	282.5	21
Totals	2,338.0	238	2,328.3	250	2,723.8	287

[a] From Bol. do Museu Goeldi 7 (1910) 48.

When a plant is introduced into new regions, it will usually be found to succeed best where the climate approaches that of its original habitat; and this rule has been found to apply to Para rubber. The successful growth of *Hevea* is not strictly limited to regions where conditions are precisely similar to those prevailing in the Amazon Valley; yet it certainly finds its optimum habitat in regions at comparatively low elevations, possessing a climate with a rainfall not much below 2,000 millimeters, evenly distributed throughout the year, and with a temperature rarely if ever falling much below 19° or 20° C., at least for any extended period. The

TABLE II.—*Rainfall at Isabela, Basilan, Philippine Islands.*[a]

[Rainfall is given in millimeters.]

Month.	1903		1904		1905		1906		1907		1908	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	15.7	5	89.2	9	13.2	2	24.5	4	70.9	6	52.6	5
February	7.1	4	272.5	13	1.5	1	17.5	2	122.9	13	148.5	16
March	0.0	0	76.2	7	0.0	0	28.2	2	87.2	12	165.3	15
April	22.5	8	206.2	12	9.6	2	100.5	11	130.9	8	119.2	10
May	108.5	9	88.4	13	102.4	15	82.5	12	121.4	15	99.6	9
June	307.6	25	84.3	12	54.0	7	365.0	21	182.9	20	171.0	17
July	131.1	14	177.8	14	140.2	18	145.4	15	270.6	17	321.3	26
August	201.9	21	189.0	15	112.4	15	231.6	22	240.1	15	200.4	17
September	186.7	19	210.8	15	145.3	15	166.3	15	138.0	13	385.5	20
October	187.9	14	221.2	14	320.9	19	315.6	15	200.5	13	128.0	15
November	289.3	14	238.8	13	112.3	7	233.4	16	135.6	19	149.4	19
December	198.6	23	31.5	6	91.2	11	100.6	9	331.9	22	279.2	17
Totals	1,656.9	156	1,885.9	143	1,103.0	112	1,811.1	144	2,032.9	173	2,220.0	186

[a] From Saderra Masó, Annual amount and distribution of rainfall in the Philippines. Manila, Weather Bureau (1914) 28.

TABLE II.—*Rainfall at Isabela, Basilan, Philippine Islands*—Continued.

Month.	1909		1910		1911		1912		1913		Mean.	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	56.7	16	43.9	11	68.9	7	108.3	5	54.4	7	54.4	7
February	142.7	12	56.6	9	152.2	9	28.8	4	31.3	4	89.2	7.9
March	25.4	5	130.0	11	0.0	0	1.8	1	126.4	14	58.2	6.1
April	29.9	8	105.7	14	173.5	4	32.3	7	50.4	10	89.2	8.5
May	142.8	21	41.1	17	224.8	19	62.1	11	114.6	15	108.0	14.2
June	163.1	18	334.6	25	65.5	13	329.3	23	258.9	23	210.6	18.5
July	369.4	18	121.0	18	116.9	9	314.7	20	184.0	13	208.4	16.5
August	283.1	23	319.6	23	212.6	14	96.5	14	176.1	12	205.8	17.4
September	155.4	15	368.2	27	138.9	16	104.6	10	217.9	11	201.6	16.0
October	364.3	17	215.6	17	275.8	12	369.0	17	280.3	15	261.7	15.4
November	178.1	19	335.1	22	13.3	3	48.6	8	118.7	9	168.4	13.5
December	59.7	12	155.8	11	97.2	7	33.0	9	146.1	6	138.6	12.1
Totals	1,970.6	184	2,227.2	205	1,539.6	113	1,529.0	129	1,759.1	139	1,794.1	153.1

humidity should also be fairly high. Such a climate is found only over limited areas within a few degrees on either side of the equator.

The amount and distribution of rainfall in the southern part of the Philippine Archipelago appears to be quite suitable for *Hevea brasiliensis.* Table II gives the rainfall at Isabela, Basilan Island, by months, with the number of rainy days in each month, over a period of eleven years.

During the period mentioned the average rainfall at Isabela has been 1,794.1 millimeters, with a minimum occurring in 1905 of 1,103 milimeters. During this time there have been but three months entirely without rain, though there is a dryer season during January, February, and March. The number of rainy days during the period under consideration has averaged 153.1, with a minimum of 112 in 1905.

In Table III are given the average rainfall and the number of rainy days at a number of other stations in the southern part of the Philippines.

TABLE III.—*Rainfall data for the southern Philippine Islands, 1903–1913.*

[Rainfall is given in millimeters.]

Month.	Jolo.		Davao.		Cotabato.		Zamboanga.	
	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.	Rainfall.	Rainy days.
January	89.1	7.4	110.2	5.9	98.8	12.6	37.2	4.9
February	122.4	7.4	141.6	7.5	88.8	10.1	62.0	5.1
March	85.2	8.1	164.2	7.5	68.1	7.8	21.0	2.5
April	118.2	7.3	190.3	9.2	164.9	12.7	38.2	5.5
May	160.2	13.5	252.8	11.6	218.5	14.7	72.0	7.6
June	203.3	15.0	234.2	11.0	237.3	17.2	88.8	10.6
July	172.0	12.2	208.9	10.2	292.0	18.4	99.0	10.6
August	170.4	13.9	207.4	10.1	271.8	18.4	95.0	10.9
September	184.4	12.5	203.6	9.8	248.6	16.7	106.3	9.5
October	222.9	16.1	242.8	11.6	255.1	15.3	116.1	10.1
November	193.0	14.5	176.4	9.2	231.7	15.9	106.5	9.4
December	144.8	14.4	208.8	10.1	133.5	13.0	84.3	8.1
Total	1,865.9	142.3	2,340.7	113.7	2,309.1	172.8	926.4	94.8

The rainfall at Zamboanga is the lightest recorded for any station in the Philippines and is given here solely for the purpose of showing the variation in rainfall that may occur within a comparatively short distance. Zamboanga is separated from Basilan by a strait but a few kilometers wide. In a range of hills only a few kilometers back of Zamboanga the rainfall is again much heavier. Davao has the heaviest and most evenly distributed rainfall of any of the stations listed. Cotabato is, however, a very close second.

Rainfall data from various localities in the East where Para rubber is being successfully grown are compiled in Table IV.

TABLE IV.—*Average rainfall in rubber-producing districts of the Orient.*

[Rainfall is given in millimeters.]

Month.	Ceylon, 1905-1908.[a]		Malaya.			Borneo, 1910-1913.[d]	
	Peradeniya.	Henaratgoda.	Kuala Lumpur, F. M. S. 1915-1916.[b]	Singapore. 1914-1916.[c]	Penang. 1914-1916.[c]	Sandakan.	Jesselton.
January	67.0	47.8	74.9	322.3	50.0	301.2	106.9
February	66.5	95.8	53.3	88.3	80.8	249.7	72.9
March	100.0	125.5	201.6	228.1	237.5	137.2	45.7
April	137.4	220.7	297.4	253.7	212.3	117.5	138.1
May	133.1	304.8	136.7	132.5	316.5	126.5	209.8
June	241.3	234.6	170.9	163.3	251.2	114.8	307.1
July	211.8	111.2	228.2	211.8	302.8	154.4	209.0
August	122.9	74.4	237.9	157.5	224.5	212.9	249.4
September	168.1	123.9	133.7	148.0	354.1	364.5	353.1
October	374.4	449.6	188.3	149.9	458.2	227.8	436.4
November	173.7	361.7	193.2	252.2	305.6	292.6	280.2
December	131.0	65.5	167.3	237.0	152.1	364.5	139.2
Total	1,927.2	2,215.5	2,083.4	2,344.6	2,945.6	2,663.0	2,542.8

[a] Report of the director, Royal Bot. Gardens of Ceylon (1906–1909).

[b] Supplement to the Official Gazette, F. M. S. Selangor Administrative report (1916–1917).

[c] The Gardens' Bulletin, Straits Settlements (1914–1916).

[d] Manual of Statistics of British North Borneo (1915).

TEMPERATURE

Hevea brasiliensis appears to reach its best development in regions having a comparatively high and uniform temperature throughout the year. At Belem (Para) near the mouth of the Amazon and about 1° south latitude the minimum temperature recorded during a period of three years was 20.2° C., and the maximum, 36.6° C.; the average yearly maximum for this period was 32.04° C., and the average yearly minimum, 22.23° C.

In the Philippines the lowest temperature recorded during a period of three years (1913–1915) at Davao was 19.0° C.; at Cotabato, 19.2° C.; and at Jolo, 20.2° C. During this period the maximum temperature at Davao was 36.0° C.; at Cotabato, 36.0° C.; and at Jolo, 33.4° C. In general the temperature in the Mindanao region appears to range between about 20° and 34° C. and is fairly uniform throughout the year, except for a somewhat warmer period during February, March, and April, when the temperature occasionally reaches 36° or 37° C.

SOIL

Hevea brasiliensis does not appear to be exacting in the quality or kind of soil necessary for its successful growth. Generally speaking, Para rubber may be said to do well on any soil that will support a heavy forest growth, provided drainage is good. *Hevea brasiliensis* is rather intolerant of excess of water in the soil, and very wet soils should be drained in order to obtain the best results. Heavy clay soil is not so suitable for the growth of rubber as are loamy or even sandy soils.

Cox[6] has shown that, in general, Philippine soils are good and contain ample quantities of the inorganic compounds necessary for plant growth. There are undoubtedly very large areas in the Mindanao region where the soils are suitable for the successful growth of *Hevea brasiliensis*. Table V gives the results of an analysis of five samples of soil taken on the Basilan Plantation Company's property on Basilan.

TABLE V.—*Soils from Basilan plantation.*[a]

	Sample No.—				
	1[b]	2[c]	3[e]	4[d]	5[e]
Nitrogen (N_2)	0.093	0.119	0.108	0.127	0.134
Phosphoric anhydride (P_2O_5)	0.063	0.078	0.086	0.067	0.075
Lime (CaO)	0.10	0.27	0.11	0.22	0.14
Potash (K_2O)	0.077	0.083	0.064	0.089	0.119
Humus	1.18	1.40	1.16	1.29	1.22
Loss on ignition	13.80	13.92	14.16	14.60	13.72
Detritus, not passing 1 mm sieve	40.4	61.1	11.1	39.6	45.8
Coarse sand, 1.0 to 0.5 mm	4.8	2.8	2.2	4.1	1.7
Medium sand, 0.5 to 0.25 mm	4.7	2.9	2.5	3.9	1.4
Fine sand, 0.25 to 0.10 mm	4.0	3.6	4.2	4.4	7.2
Very fine sand, 0.10 to 0.05 mm	6.1	6.9	1.1	8.0	6.7
Silt, 0.05 to 0.01 mm	4.6	4.6	11.7	2.4	0.7
Fine silt, 0.01 to 0.002 mm	18.9	28.6	24.8	22.5	22.0
Clay, less than 0.002 mm	56.9	50.6	53.5	54.7	60.3
Total (except detritus)	100.0	100.0	100.0	100.0	100.0

[a] Analyzed by A. S. Argüelles, Bureau of Science, Manila, P. I.
[b] Rolling land; trees (*Hevea*) poor.
[c] Sandy loam; coconuts.
[d] Gently rolling land; trees (*Hevea*) good.
[e] Swampy land; *Hevea*.

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[6] Philip. Journ. Sci. § A 6 (1911) 279-330.

The samples were taken at a depth of about 30 to 40 centimeters. Sample 1 was taken from a block planted to Para rubber in which the growth of the trees was very poor. The trees presented an unhealthy, ill-nourished appearance. It is interesting that analysis of the soil from this block showed it to be low in all inorganic substances necessary for plant growth.

In Table VI are given analyses of other soils from the Mindanao region of the Philippines, in Table VII analyses of Ceylon soils are tabulated for comparison, and in Table VIII analyses of soils from the Federated Malay States are given. The Malayan soils are characterized by their richness in nitrogen.

TABLE VI.—*Philippine soils.* [a]

	Cotabato.	Fort Pikit, 10 to 40 cm.	Lake Lanao, north side; 10 to 40 cm.	Lake Lanao, south side; 10 to 40 cm.	Sarangani, 10 to 40 cm.
Sample No.	161	159	150	153	165
Moisture	8.35	18.47	16.61	3.56	4.48
Loss on ignition	10.16	11.39	19.47	7.30	5.58
Nitrogen (N)	0.207	0.184	0.216	0.173	0.115
Phosphoric anhydride (P_2O_5)	0.142	0.196	0.180	0.097	0.188
Lime (CaO)	0.87	1.92	0.37	2.24	3.18
Magnesia (MgO)	---------	2.31	0.26	---------	0.71
Potash (K_2O)	0.29	0.55	0.240	0.173	0.24
Soda (Na_2O)	0.76				
Humus	---------	3.25	2.12	2.55	2.17
Soil acidity (per cent $CaCO_2$)	---------	0.0036	0.0022	0.0072	0.0000
Detritus—not passing 1 mm sieve	---------	small	small	2.29	small
Coarse sand, 1.0 to 0.5 mm	---------	0.99	2.61	3.81	5.76
Medium sand, 0.5 to 0.25 mm	---------	4.33	13.20	27.68	19.37
Fine sand, 0.25 to 0.10 mm	---------	7.11	18.80	24.81	25.84
Very fine sand, 0.10 to 0.05 mm	---------	13.81	13.82	18.09	18.08
Silt, 0.05 to 0.005 mm	---------	59.30	28.48	20.45	23.20
Clay, less than 0.005 mm	---------	14.11	23.61	5.35	7.89
	---------	99.65	100.52	100.19	100.14

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[a] Cox, Philip. Journ. Sci. § A 6 (1911) 279–330, from Table VIII, p. 309, and Table IX, pp. 314 and 315.

TABLE VII.—*Ceylon soils.*[a]

	Cabooky soil.	Alluvial soil. Experiment station, Peradeniya.	Cacao land interplanted with rubber.	Tea land interplanted with rubber.	Swampy land, black soil.
Moisture	3.800	3.000	3.000	3.000	5.600
Organic matter and combined water	8.000	11.000	4.600	6.000	20.400
Oxide of iron and manganese	7.400	8.000	7.200	5.200	1.200
Oxide of alumina	8.200	9.717	6.786	13.049	5.232
Lime	0.060	0.130	0.160	0.160	0.050
Magnesia	0.054	0.259	0.216	0.490	0.115
Potash	0.085	0.162	0.077	0.401	0.061
Phosphoric acid	0.010	0.076	0.064	0.089	0.064
Soda	0.074	0.188	0.233	0.137	0.182
Sulphuric acid	0.008	0.054	0.048	0.068	0.048
Chlorine	0.003	0.014	0.016	0.006	0.048
Sands and silicates	72.806	67.400	77.000	71.400	67.000
	100.000	100.000	100.000	100.000	100.000
Containing nitrogen	0.128	0.230	0.100	0.162	0.448
Equal to ammonia	0.156	0.280	0.122	0.195	0.554
Lower oxide of iron	trace	much	trace	trace	much
Acidity	much	neutral	fair	much	much
Citric soluble potash	0.006	0.013	0.008	0.025	0.009
Citric soluble phosphoric acid	nil	trace	nil	trace	nil
Fine soil passing 90 mesh	11.50	53.90	48.00	34.00	59.00
Fine soil passing 60 mesh	9.50	43.00	42.00	25.00	36.00
Medium soil passing 30 mesh	4.00	3.00	8.00	10.00	1.00
Coarse sand and small stones	75.00	0.10	2.00	31.00	4.00
	100.00	100.00	100.00	100.00	100.00

[a] From Circulars and Agr. Journ. Roy. Bot. Gard. Ceylon 3 (1905) 67-72.

TABLE VIII.—*Soils of the Federated Malay States.*[*]

	Alluvial clays.			Sandy loams.						
		Subsoil.								
Moisture	6.920	5.560	5.000	4.200	2.000	1.400	4.000	2.200	2.600	1.800
Organic matter and combined water	24.080	16.640	8.000	9.000	4.400	3.000	9.600	5.600	6.000	9.200
Oxide of iron and manganese	1.120	1.200	3.000	1.500	2.400	0.300	8.240	0.700	0.300	4.000
Oxide of alumina	2.971	3.019	2.520	5.690	1.855	1.165	4.183	2.516	2.958	4.951
Lime	0.284	0.200	0.160	0.200	0.160	0.140	0.160	0.160	0.140	0.240
Magnesia	0.252	0.381	0.230	0.100	0.086	0.130	0.100	0.130	0.130	0.144
Potash	0.131	0.169	0.014	0.046	0.023	0.014	0.053	0.030	0.021	0.014
Phosphoric acid	0.025	0.012	0.076	0.064	0.076	0.051	0.064	0.064	0.051	0.051
Sand and silicate	64.200	72.800	81.000	79.200	89.000	93.800	73.600	88.600	87.800	79.600
Chlorine	0.017	0.019	--------	--------	--------	--------	--------	--------	--------	--------
	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Containing nitrogen	0.667	0.425	0.403	0.392	0.425	0.492	0.386	0.403	0.369	0.464
Equal to ammonia	0.810	0.516	0.489	0.476	0.516	0.598	0.469	0.489	0.448	0.564
Lower oxide of iron	much	fair	good	good	good	good	good	good	good	good
Acidity	--------	--------	marked	marked	marked	marked	marked	marked	marked	marked
Fine soil passing 90 mesh	96.00	95.50	68.00	32.00	48.00	30.00	36.00	26.00	16.00	30.00
Fine soil passing 60 mesh	4.00	4.50	32.00	34.00	36.00	34.00	38.00	30.00	24.00	30.00
Medium passing 30 mesh	--------	--------	--------	12.00	12.00	26.00	8.00	22.00	28.00	14.00
Coarse sand and small stones	--------	--------	--------	22.00	4.00	10.00	18.00	22.00	32.00	26.00
	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000

[*] From Report of Director of Agriculture of F. M. S. for 1906, 8.

ELEVATION

Hevea brasiliensis appears to make its most rapid growth at low elevations. Though it has been grown in Ceylon and elsewhere at elevations up to 600 meters or more, the rate of growth is apparently much less rapid. It is probable that the retardative effect of altitude upon rubber is related to the lower temperatures prevailing at higher elevations. The extreme retarding effect of high elevations on the growth of trees in the Tropics is shown by the dwarfed condition of vegetation on mountain tops in these regions.

Table IX gives the results of an experiment in Malaya to show the effect of altitude upon the growth of *Hevea*. While the small number of trees observed, especially at the higher altitudes, renders the results somewhat inconclusive, yet the experiment indicates a considerable reduction in the rate of growth as elevation is increased. The trees in clearing 8 were, however, said to be as healthy as those in clearing 1.

TABLE IX.—*Experiment on Gunong Angsi.*[a]

Clearing.	Elevation.		Trees ready to tap.	Total trees.	Percentage.
	Feet.	*Meters.*			
1	300	91.44	365	529	69
2	600	182.88	32	180	18
3	1,000	304.80	321	665	48
4	1,200	365.76	(b)	(b)	(b)
5	1,600	487.68	24	90	27
6	1,800	574.84	17	91	18
7	2,100	640.08	....	66	....
8	2,400	731.52	2	90	2

[a] From Agr. Bull. Straits & F. M. S. 10 (1911) 257.

[b] Not planted.

GROWTH IN THE PHILIPPINES

It appears from the preceding discussion that climatic and soil conditions in the Mindanao region of the Philippine Islands compare well with those in regions in the eastern Tropics where plantation rubber is now being successfully produced. It remains to compare actual measurements of growth and yield of rubber of trees growing in the Philippines with those in other rubber-producing districts. In Table X a series of measurements is given of trees of various ages growing in the Philippines, and an attempt has been made to determine from these measurements the rate of growth of *Hevea* up to the age of about 10 years.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands.*

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
1	100.0	64.0	57.0	28.5	103.5	33.0	57.0	34.0	44.0	15.0
2	91.5	60.0	53.0	40.0	70.0	30.0	70.0	55.0	36.5	11.0
3	113.0	40.0	40.0	47.0	65.0	44.0	61.0	49.0	42.0	21.0
4	91.0	56.5	61.0	32.0	66.5	44.0	58.5	51.5	42.5	12.0
5	86.5	64.0	39.0	25.0	61.5	50.0	58.0	37.0	66.0	13.0
6	76.0	57.5	45.0	80.0	63.5	31.5	56.0	53.0	46.5	16.0
7	86.0	51.0	36.5	35.0	57.0	23.5	52.0	49.0	53.0	18.0
8	73.5	48.5	40.0	30.0	53.0	37.0	75.0	59.5	41.5	15.5
9	78.0	51.0	34.0	27.0	65.0	23.0	63.0	64.5	53.5	14.0
10	86.0	54.0	39.0	32.0	61.0	31.5	67.0	47.0	48.0	11.0
11	91.0	61.0	46.0	37.0	77.0	45.0	53.0	63.0	50.0	18.5
12	142.0	67.0	37.0	33.0	55.5	49.0	78.5	48.0	50.0	11.0
13	84.0	56.0	49.0	35.5	76.0	38.0	67.0	59.0	45.0	12.0
14	69.0	67.0	38.0	37.0	52.0	52.5	64.0	67.0	50.0	15.0
15	73.0	55.0	53.5	35.5	65.0	30.0	57.0	53.0	41.0	13.5
16	81.0	51.0	59.0	36.5	53.0	38.0	66.0	64.5	48.5	13.0
17	76.0	64.0	65.0	27.5	90.0	22.5	46.0	63.0	48.0	18.0
18	87.0	55.0	54.0	25.5	68.5	25.0	59.0	47.0	42.0	15.0
19	126.0	48.0	55.0	37.0	57.5	33.0	45.0	54.0	48.0	15.0
20	74.0	52.0	53.0	27.0	54.0	55.0	69.0	52.5	52.0	13.5
21	77.0	60.5	53.5	28.5	51.0	23.0	55.6	61.0	48.0	16.5
22	109.5	67.0	54.5	34.0	50.5	28.5	54.0	58.5	48.0	14.0
23	88.0	49.5	47.0	38.0	64.0	25.5	74.0	64.0	62.0	10.0
24	105.5	62.0	47.0	43.0	62.0	24.0	49.0	49.5	42.5	14.0
25	77.5	73.0	58.5	35.0	71.0	42.0	64.0	62.0	63.0	11.0
26	78.5	59.0	51.5	39.0	70.0	42.0	80.0	51.0	63.5	14.5
27	96.0	65.5	52.0	35.0	78.0	23.5	53.0	60.0	45.0	------
28	78.0	60.0	65.0	35.0	63.0	28.0	73.0	55.0	49.5	------
29	133.5	54.0	48.5	48.5	60.0	39.0	56.0	39.0	55.0	------
30	87.5	59.0	49.5	34.5	------	34.0	75.0	52.0	52.0	------
31	73.5	64.0	77.0	38.0	------	24.0	61.5	68.0	46.0	------
32	74.0	64.0	45.5	35.5	------	30.0	76.0	57.0	52.5	------
33	97.5	51.0	45.0	30.0	------	27.5	60.0	43.0	36.0	------
34	102.5	53.5	45.0	32.0	------	23.0	57.0	46.0	48.0	------

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands*—Ctd.

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
35	77.0	56.5	46.0	39.0		34.0	59.0	51.5	44.0	
36	89.0	68.0	59.0	38.0		24.0	58.0	61.0	47.0	
37	77.5	56.0	52.0	41.0		39.0	53.0	62.0	53.0	
38	75.0	65.0	41.5	38.0		34.0	76.0	58.5	45.5	
39	111.0	53.0	50.0	30.5			70.5	49.0	41.0	
40	80.0	60.5	63.0	42.0			56.0	61.5	39.5	
41	83.0	59.0	33.0	46.0			50.0	45.5	53.0	
42	84.0	68.0	51.0	42.0			56.0	63.0	41.5	
43	98.5	65.0	50.5	37.0			58.5	52.0	53.0	
44	105.0	54.5	47.0	41.4			63.0	51.0	49.0	
45	84.0	56.0	48.0	38.0			63.5	55.0	44.0	
46	85.5	59.0	58.5	43.0			65.0	52.0	47.0	
47	101.5	58.0	60.0	33.0			68.0	65.5	37.0	
48	86.0	67.0	46.0	23.5			59.5	66.0	35.0	
49	89.0	60.0	34.5	34.0			59.0	66.5	47.0	
50	93.5	59.0	47.0	35.0			60.0	63.0	43.0	
51	92.0	60.0	33.0	28.0			61.0	60.5	45.5	
52	76.0	56.5	43.0	34.5				61.0	52.0	
53	83.5	74.5	50.0	40.5				58.0	51.5	
54	83.0		34.0	33.0				58.0	36.0	
55	86.5		46.0	32.5					46.0	
56	98.0		52.5	32.5					56.0	
57	80.5		51.5	50.0					39.0	
58	124.0		85.0						49.5	
59	91.0		51.0						46.0	
60	78.0		52.0						46.0	
61	101.0		53.0						44.0	
62	109.5								52.0	
63	77.0								35.0	
64	86.5								60.0	
65	83.5								48.0	
66	93.5								34.0	
67	91.5								45.0	
68	105.5								49.0	

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

TABLE X.—*Growth of Hevea rubber trees in the Philippine Islands*—Ctd.

Order No.	Girth of trees in block No.—									
	2[a]	2[b]	3[c]	5[d]	7[e]	9[f]	10[g]	10[h]	18[i]	25[j]
69	84.5								55.0	
70	82.0								54.5	
71	84.0								59.5	
72	81.0								50.0	
73	104.5								44.0	
74	92.0								38.5	
75	87.0								58.5	
76	78.0								62.0	
77	75.0								49.5	
78	87.0								49.5	
79	104.0								63.0	
80	77.5								55.0	
81	93.0								55.0	
82	80.0								51.5	
83	91.0								43.5	
84	95.5								48.0	
85	82.0								44.0	
86									47.0	
87									48.0	
88									49.0	
89									36.5	
90									50.0	
91									43.5	
92									52.0	
93									40.0	
94									38.0	
95									54.0	
96									39.5	
97									44.0	
Average	89.4	58.4	46.3	35.4	64.9	33.9	61.7	55.5	47.8	14.2
Maximum	142.0	74.5	65.0	50.0	103.0	55.0	80.0	68.0	66.0	21.0
Minimum	69.0	40.0	33.0	23.5	50.5	22.5	45.0	34.0	36.5	10.0

[a] Planted in June, 1907; land flat; planting rather irregular but probably originally planted about 2.44 by 4.88 meters (8 by 16 feet); age, 124 months.

[b] Planted in June, 1910; 2.44 by 2.44 meters (8 by 8 feet) on a flat; age, 88 months.

[c] Planted in July, 1912; 5.49 by 5.49 meters (18 by 18 feet) on gently rolling ground; age, 63 months.

[d] Planted in May, 1913; 5.49 by 5.49 meters (18 by 18 feet); land slightly sloping; age, 53 months.

[e] Planted in August, 1910; originally interplanted with hemp at somewhat irregular distances, average about 4.57 by 5.49 meters (15 by 18 feet); land slightly sloping; age, 86 months.

[f] Planted in June, 1914; 5.49 by 5.49 meters (18 by 18 feet), on a steep hillside; age, 41 months.

[g] Planted in June, 1911, on a moderate slope, 4.88 by 4.88 meters (16 by 16 feet); age, 76 months.

[h] Planted in June, 1911, on a gentle slope, 5.49 by 5.49 meters (18 by 18 feet); age, 76 months.

[i] Planted in July, 1913, on practically level land, 5.49 by 5.49 meters (18 by 18 feet); age, 51 months.

[j] Planted in June, 1916, on slightly rolling land, 5.49 by 5.49 meters (18 by 18 feet); age, 17 months.

It is recognized that the results are subject to criticism from a scientific viewpoint, but it is believed definite data in regard to the girth of *Hevea brasiliensis* in the Philippine Islands are of sufficient practical importance to warrant their publication. It would undoubtedly have been desirable to remeasure the same trees through several successive years; but, since this has not been practicable, the results of the present series are given in the table to show the growth attained by trees at certain known ages. An attempt has been made, by averaging a number of measurements, to neutralize individual variation among trees of the same age as such variation in *Hevea* is well known to be considerable. Under apparently identical conditions certain individuals may attain as great a girth in five years as others do in seven or eight years.

Conditions of cultivation are approximately equal for all the trees considered. A strip about 3 meters wide is kept clean-weeded along the rows, and the remainder plowed about three times each year. The older trees were planted at various distances, but later plantings are all 5.49 by 5.49 meters (18 by 18 feet). In each case the planting distance is indicated. In the older blocks the retarding effect of close planting on the growth of the trees is very evident. The trees have practically all been tapped since they attained a diameter of 50.8 centimeters (20 inches) at 45.7 centimeters (18 inches) above the ground.

MEASUREMENTS OF TREES ON BASILAN ISLAND

In Table X the measurements of five hundred fifty-one trees of various ages are given. The age in months of each group is recorded, together with the planting distance and general character of the land. Measurements were made with a tape to the nearest 5 millimeters at 1 meter above the ground. For each group the maximum, minimum, and average girths are indicated. A certain error is caused by the fact that the measurements were necessarily made over the tapping surface, but this error is probably never very great and is in the direction of a reduction rather than an increase in the recorded girth of trees at the various ages. Most of the measurements of trees in other countries with which the Philippine trees are compared have been measured at 1 yard from the ground; and, since the trunks of *Hevea brasiliensis* taper rather abruptly, this difference in height of measurement has the result of reducing the girth of the Philippine trees when compared with others. This comparative reduction ranges from a few millimeters for the younger trees up to approximately 1 centimeter for trees 10 years of age. It has not been found practicable to apply any correction for this difference due to height of measurement; but when comparing the girth of trees measured at different heights, the fact should be borne in mind that such difference exists and that it increases with the size of the tree.

In fig. 1 is plotted the average circumference of trees of the various ages measured, and from this curve the average circumference of trees from 1 to 10 years old has been calculated. The results obtained in this manner are given in Table XI.

TABLE XI.—*Diameters attained by average trees in Basilan. From 1 to 10 years old with increment.*

Age in years.	Circumference.	Increment.
	cm.	*cm.*
1	10.3	10.3
2	18.7	8.4
3	27.2	8.5
4	35.6	8.4
5	44.0	8.4
6	52.4	8.4
7	60.9	8.5
8	69.4	8.5
9	77.9	8.5
10	86.5	8.6

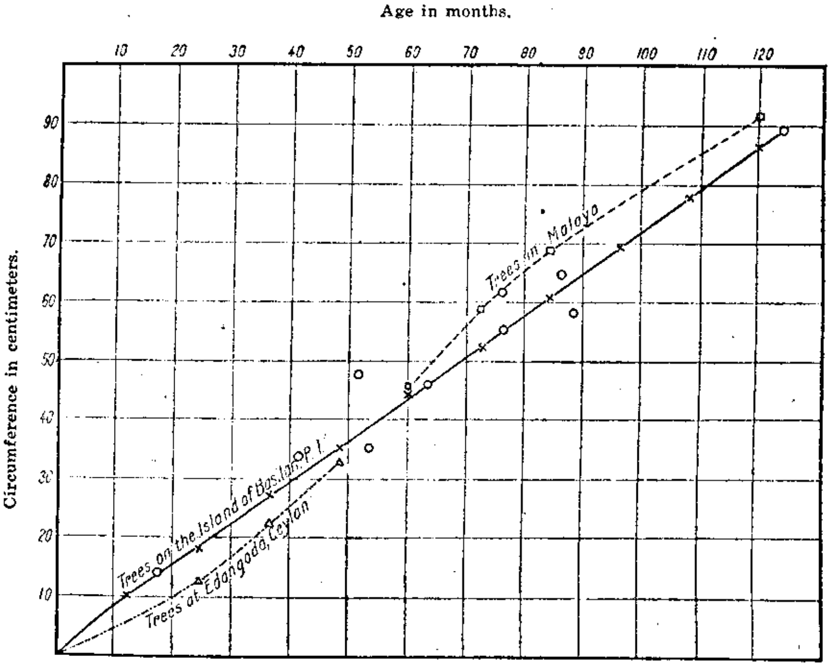

FIG. 1. Comparison of the growth of *Hevea brasiliensis* in the Philippine Islands with that in Ceylon and Malaya.

In the same figure are also plotted the figures given in Table XV for the growth of trees at Edangoda, Ceylon, and also the second of the two series of measurements of trees 5 to 9 years old given in Table XII.

From Table XI it appears that the annual increase in circumference of trees up to 10 years of age averages 8.6 centimeters. Ridley[7] gives measurements of trees in Malaya which approach very closely those recorded for trees in the Philippines. Table XII is copied from Ridley's paper, with the measurements reduced to centimeters.

TABLE XII.—*Growth of trees in Malaya.*[a]

Age in years.	1904		1905		1906		1909		Increment, six years.	
	cm.	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*	*cm.*	*Inches.*
5	44.77	17⅝	54.61	21½	65.72	25⅞	89.85	35⅜	45.09	17¾
5	45.88	18⅝	58.55	23½	68.80	27⅛	91.63	36¾	45.75	18⅛
16	115.57	45¾	120.97	47⅝	129.54	51	149.23	58¾	33.02	13
28	278.13	109½	283.84	111¾	288.92	113¾	306.07	120½	27.94	11

[a] From Agr. Bull. Straits & F. M. S. 9 (1910) 257.

His measurements of trees from 5 to 9 years of age indicate a somewhat faster growth than is shown by trees in Basilan, but this may be due to the effect of close planting on the latter. In the same paper Ridley shows that in a block of closely planted trees the outside trees grew 20.3 centimeters in six years, while those inside grew only 10.3 centimeters during the same period. He also states that he considers a growth under fair conditions of 7.6 to 10.2 centimeters (3 to 4 inches) per year, for trees from 5 to 15 years of age, to be satisfactory. The average yearly increment of all trees measured in the Philippines appears to be about 8.6 centimeters (3.4 inches). An average of ninety-seven trees in block 18 indicates a growth of 47.8 centimeters (18.0 inches) in fifty-one months, which amounts to about 11.2 centimeters (4.4 inches) per year.

Ridley[8] gives the measurements of some trees growing under jungle conditions in the Singapore Botanic Gardens. A copy of his table appears in Table XIII with the measurements reduced to centimeters. The trees were planted about ten years before the first measurements were made. He states that they are fully twice as large as trees grown under cultivation.

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[7] Agr. Bull. Straits and F. M. S. 9 (1910) 25.

[8] Agr. Bull. Straits & F. M. S. 7 (1908) 254.

TABLE XIII.—*Growth of trees in the Singapore Botanic Gardens.*[a]

[Age of trees, 14 years.]

Registered No. of tree.	Girth in—					Remarks.
	1904	1905	1906	1907	1908	
1272	97.8	102.9	108.5	113.6	121.9	Slope.
1273	78.7	81.3	88.3	93.3	96.5	Do.
1275	60.9	62.2	66.0	68.6	71.1	Do.
1276	136.5	147.0	147.3	151.1	152.4	Top of hill.
1277	153.7	159.7	166.1	174.0	182.9	Top of hill, 100 feet tall.
1278	86.4	88.9	90.5	93.7	96.5	Slope.
1279	87.0	92.7	96.5	101.6	104.1	Do.
1280	86.1	93.7	105.1	106.1	108.0	Do.
1281	158.4	173.0	181.3	191.8	200.7	Top of hill.

[a] From Agr. Bull. Straits & F. M. S. **7** (1908) 254.

The record extends over a period of four years and indicates an average growth during this period of 5.3 centimeters per year. The most rapidly growing tree, No. 1281, shows a growth of 10.5 centimeters per year, almost double that of the average.

In Table XIV are given measurements of trees up to 3 years old. The best growth indicated for that period is 23.9 centimeters, which is slightly less than that attained by trees of the same age at Basilan.

TABLE XIV.—*Open-planting experiments. Planted 7.5 by 3.75 meters (25 by 12.5 feet).*[a]

Seeds sown at stake, 1907.			Stumps 2 months from nursery.			Stumps 6 months from nursery.		
			Seeds sown in nursery, October, 1907.			Seeds sown in nursery, October, 1907.		
	cm.	*in.*		*cm.*	*in.*		*cm.*	*in.*
October, 1907	planted.	planted.	December, 1907	planted.	planted.	April, 1908	2.4	$\frac{15}{16}$
October, 1908	8.1	3$\frac{3}{16}$	December, 1908	6.5	2$\frac{9}{16}$	April, 1909	7.9	3$\frac{1}{8}$
October, 1909	16.1	6$\frac{1}{3}$	December, 1909	14.2	5$\frac{3}{5}$	April, 1910	23.0	9$\frac{1}{16}$
October, 1910	23.6	9$\frac{3}{16}$	December, 1910	23.9	9$\frac{2}{5}$			

[a] From Report of Director of Agriculture F. M. S. in Agr. Bull. Straits & F. M. S. **10** (1911) 255–256.

Other records from Malaya indicate in some cases more rapid growth than those cited. In measurements of certain trees on the Bukit Raja Estate in Selangor[9] in which five trees (Nos. 1, 3, 6, 7, 8), all approximately 4 years of age, attained an average circumference of 47.8 centimeters at 1.36 meters (4.5 feet) above the ground. However, even this rate of growth is exceeded by certain selected trees in Basilan. The best group of three consecutive trees in block 18 (Nos. 79, 80, 81) shows an average girth of 57.7 centimeters (22.7 inches) at the age of 51 months, which is equivalent to about 54.24 centimeters (21.3 inches) at the age of 4 years.

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[9] Agr. Bull. Straits & F. M. S. **1** (1902) 333.

Willis[10] presents the measurements of some trees in Ceylon. The original trees, planted at Henaratgoda in 1876 when probably about 1 year old, attained a girth of 35.6 centimeters (14 inches) two years later, and in 1882 the largest tree was 63.5 centimeters (25 inches) in circumference 1 yard from the ground. The girth of this tree was measured annually thereafter and in 1886, when 10 years of age, its girth was 124.5 centimeters (49 inches). Even this growth appears to be inferior to that attained by the best tree measured at Basilan, No. 12 in block 2, which attained a circumference of 142 centimeters (55.9 inches) at an age of 124 months.

In the same paper Willis gives the average measurements of trees at Edangoda and Yattipowa, Ceylon. Willis' figures are given in Table XV.

TABLE XV.—*Growth of trees in Ceylon.*

Locality.	Age.	Trees.	Circumference.	
	Years.		*cm.*	*in.*
Edangoda	4	100	32.9	12.96
Do	3	50	22.2	8.75
Do	2	20	12.6	4.96
Yattipawa	3	108	23.8	9.37
Do	3	108	23.2	9.13

The trees were measured 3 feet above the ground and so are closely comparable with measurements in the Philippines made at a height of 1 meter. These measurements indicate a decidedly slower growth than is shown by trees of the same age in Basilan. At an age of 4 years the circumference attained by trees at Edangoda was 2.7 centimeters (1.1 inches) less than that of trees of the same age in the Philippines. Other measurements of Para rubber trees recorded from Ceylon indicate that the rate of growth in that country, while rather variable, is in general considerably less rapid than in Malaya.

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[10] Circular and Bull. Roy. Bot. Gard. Ceylon 5 (1910) 17 and 18.

Johnson[11] gives girth measurements of trees in the Tarkwa Botanic Station, Gold Coast. Data from his table are presented in Table XVI. The rate of growth does not appear to differ greatly from that of trees of the same ages in the Philippines.

TABLE XVI.—*Growth of Para rubber at the Tarkwa Botanic Station, Gold Coast.*

Plot No.	Date of planting.	Distance planted.		Girth at 3 feet from ground.			
				December, 1905.		December, 1906.	
	1904.	*Feet.*	*Meters.*	*cm.*	*in.*	*cm.*	*in.*
I	June	15 by 15	4.5 by 4.5	17.78	7	30.48	12
II	do	12 by 12	3.6 by 3.6	15.24	6	25.40	10
III	July	15 by 15	4.5 by 4.5	15.24	6	25.40	10
IV	do	20 by 20	6.0 by 6.0	15.24	6	27.94	11
V	do	30 by 30	9.0 by 9.0	10.16	4	22.86	9
VI	do	40 by 40	12.0 by 12.0	10.16	4	22.86	9
VII	do	12 by 12	3.6 by 3.6	10.16	4	22.36	9
VIII	August and September	12 by 12	3.6 by 3.6	10.16	4	25.40	10

While much additional information in regard to the growth of *Hevea* is available, it is believed that sufficient material has been presented to indicate that the rate of growth of Para rubber in the Philippines compares favorably with that recorded elsewhere.

YIELDS OF HEVEA BRASILIENSIS

The yield obtained from Para rubber trees now being tapped in the Philippines is very satisfactory and seems to compare well with that obtained in other countries from trees of the same ages. The rubber obtained in 1916 from 20,510 trees in tapping by the end of the year was 14,991 kilograms (32,982 pounds), or an average of 0.73 kilograms (1.6 pounds) per tree. Almost 6,000 of these trees came into tapping during 1916 and 11,000 in 1915. The oldest trees were between 8 and 9 years of age at that time. Unfortunately no separate record has been kept of the yield from trees of different ages, and this renders difficult a comparison with the yields obtained in other countries.

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[11] Johnson, The Cultivation and Preparation of Para Rubber, 2d ed. (1909) 25.

Records of yields from an estate in the Federated Malay States[12] indicate that trees 6 years old produced 215.5 kilograms per hectare (192 pounds per acre); trees 8 years old, a yield of 288.5 kilograms per hectare (257 pounds per acre); and trees 9 years old, 401.9 kilograms per hectare (358 pounds per acre). This yield may be compared with that at Basilan for trees (most of them only 4 to 6 years old) which, assuming there were 331 trees per hectare (134 per acre), amounts to about 241 kilograms per hectare (215 pounds per acre).

Carruthers[13] reports that in 1907 the average yield of dry rubber over the entire Malay Peninsula amounted to 0.79 kilogram (1 pound, 12 ounces) per tapped tree, and in Selangor 0.65 kilogram (1 pound, 7 ounces) per tapped tree. The average yield obtained in Malaya in 1907 compares perhaps most closely with the yields obtained in Basilan of any records available, since in both cases the trees were young and a very high percentage of the total number was tapped for the first time.

Johnson[14] gives records of the yield obtained on a number of Ceylon and Malayan estates. The average of yields from fourteen estates in 1905 was 0.61 kilogram (1.35 pounds) per tree. The total number of trees considered was 80,272. The greatest yield recorded was 1.47 kilograms (3.25 pounds) per tree but that was for only 100 trees. The greatest yield for a large number of trees was 1.32 kilograms (3 pounds) per tree for 10,000 trees. The average of the yields from twenty-two estates in 1906 was 0.67 kilogram (1.47 pounds). The greatest yield recorded was 3.23 kilograms (7.11 pounds) per tree for 807 trees. The average of yields from eighteen estates in 1907 was 0.83 kilogram (1.83 pounds) per tree. The highest yield was 1.49 kilograms (3.28 pounds) per tree for 68,236 trees.

A discussion of the records of yields obtained from Para rubber could be continued indefinitely, but it is believed that sufficient data have been presented to show that the yield obtained from *Hevea* on Basilan compare favorably with that obtained from young trees in Malaya and Ceylon.

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[12] India Rubber Journ. No. 22, 53 (1917) 14.

[13] Agr. Bull. Straits & F. M. S. 7 (1908) 532.

[14] The Cultivation and Preparation of Para Rubber. London (1909) 149–152.

CONCLUSIONS

1. A comparison of rainfall, temperature, and soil conditions obtaining in the southern part of the Philippine Archipelago with those in countries where Para rubber is successfully cultivated indicates the suitability of the former region for *Hevea brasiliensis*.

2. Measurements of *Hevea brasiliensis* at present growing in the Philippines show a rate of growth comparing favorably with records of the growth of *Hevea* in Ceylon and Malaya.

3. Yields obtained from Para rubber trees now being tapped are satisfactory and compare well with those obtained in Ceylon and Malaya.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Chart, showing a comparison of the growth of *Hevea brasiliensis* in the Philippine Islands and in Ceylon and Malaya.

A BIOLOGICAL AND SYSTEMATIC STUDY OF PHILIPPINE PLANT GALLS[1]

By Leopoldo B. Uichanco

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FIFTEEN PLATES

INTRODUCTION

Galls are abnormal growths on the stems, leaves, roots, or other parts of plants, caused by the action of insects, arachnids, or fungi, or by unknown agencies. Just how these peculiar structural developments are brought about is still open to discussion and speculation, experimental proofs being, up to the present, too deficient to warrant our drawing any definite conclusion. These malformations have been ascribed to various causes, the more commonly accepted, in the absence of more reasonable, explanations being the following:[2] 1, a severe mechanical injury to certain parts of the plant; 2, a continuous mechanical irritation; 3, secretion of chemical stimulus by the causal animal or fungus. One, or a combination of two or all, of these causes may give rise to the production of galls. In the formation of zoöcecidia, the third factor—that is, the action of the virus secreted at the time of oviposition or during the development of the parasite—is probably the most important, the first two being of minor or absolutely no use whatever. This fact was shown by Molliard in connection with his experiments on *Aulax papaveris* Perris, a cynipid gall maker on the pistil of *Papaver rhoeas* Pall.[3] From time to time he removed a small quantity of the virus secreted by the developing *Aulax* larva, and injected the fluid into the growing pistils of *Papaver*. This artificial treatment resulted in the formation of galls which resembled in all respects those formed in the presence of the larva itself. He was thus enabled to draw the conclusion that the virus alone, without the influence of mechanical irritation from the presence of the animal within, is sufficient to produce the characteristic *Papaver* gall. The importance of chemical stimuli, as related to gall formation, was recognized as early as 1686 by Malpighi, a physician to Innocent XII, and professor of medicine at Bologna and, later, at Messina. In his De Gallis, which is the earliest systematic treatise on galls, he maintained that, at least in the case of *Cynips*, the galls formed on the plant were caused by a certain acid secreted by the insects.[4] A more recent paper by A. Cosens has the following to say in connection with these chemical secretions:[5]

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[1] Thesis presented in partial fulfillment of the requirements for the degree of Master of Science, University of the Philippines, 1918.

[2] Cook, M. T., Insect Galls of Indiana. Dept. Géol. and Nat. Resources, Indiana, 29th Ann. Rep. (1904) 801.

[3] Compt. Rend. Acad. Sci. 165 (1917) 160.

> The larva secretes an enzyme capable of changing starch to sugar [and] which acts on the starchy constituents of the nutritive zone [of the gall] and accelerates the rate of their change to sugar. The material thus prepared supplies nourishment to both the larva and the gall.

Galls can be produced only "when the tissue of the plant is interfered with during, or prior to, the actual development of the tissue."[6] After the plant tissue has become fully matured, no amount of stimulus, whether physical or chemical, will lead to the formation of galls.

In the present work only galls caused by the action of animals, known as zoöcecidia, are taken into consideration. A zoöcecidium may be caused by the action of a member of either of two zoölogical classes—Insecta and Arachnida. Galls caused by the former vary in structure from a simple convolution in the leaf lamina or a swelling in the stem to a more or less complex formation on different parts of the plant. Insects that have the power of producing plant galls are confined to the following orders and families:

Order.	Families.
1. Rhynchota, or Hemiptera.	Psyllidæ, Aphididæ, and Coccidæ.
2. Diptera.	Itonididæ, or Cecidomyiidæ, and Trypetidæ.
3. Hymenoptera.	Cynipidæ and Tenthredinidæ.
4. Lepidoptera.	Gelechidæ.
5. Coleoptera.	Buprestidæ.[7]
6. Thysanoptera.	

Arachnid gall-makers are all mites, which are members of the family Eriophyidæ (formerly called Phytoptidæ). Galls caused by this family are called erinea[8] and are generally simple convolutions in the leaf lamina, with hairy outgrowth on the concave surfaces. When the gall is young, the gall-making eriophyids are found among these hair tufts.

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[4] Cook, M. T., op. cit. 802.

[5] Trans. Canad. Inst. 9 (1912) 297–387; [Ent. News 24 (1913) 187–189.]

[6] Butler, F. H., Galls. Encycl. Brit. 11 (1910) 425.

[7] Cook, M. T., op. cit. 802.

[8] Banks, Nathan, Acarina or Mites, *Rep. U. S. Dept. Agr.* 108 (1915) 135.

OBJECT AND METHODS

Very little is known about Oriental galls, the only noteworthy treatise on the subject being the series of articles on Javanese, Sumatran, and Celebes galls by W. and J. Docters van Leeuwen-Reijnvaan. These publications are almost purely botanical in their nature, the causal animal being merely mentioned in passing in practically all cases. On account of the very close resemblance existing between the fauna and the flora of the Philippines and those of the Dutch East Indies, I found in the works of the authors just mentioned much valuable assistance in the preparation of the present paper.

In the Philippines the subject of plant galls is one which covers an absolutely virgin field, practically no attention having been paid to these curious abnormalities in this country. Although including many new and interesting species, the results of the present investigation do not pretend to be anything more than a mere breaking of ground for a future more thorough and comprehensive series of investigations along this line. This branch of research bids fair to be highly productive of results in the way of elucidating obscure facts relative to these interesting formations.

In gathering the materials for the study of galls, excursions were made to points in the vicinity of Los Baños, Laguna Province, Luzon, and especially to the thickets adjoining the college farm, the forests of Mount Maquiling, Balong Bulo Hill (near the college farm), the adjoining lowlands and valleys, and along the banks of Molauin Creek. The forests around Los Baños Falls and the thickets at the outskirts and in the barrios of Bay, Los Baños, Calamba, Cabuyao, Santa Rosa, and Biñan were visited several times and search made for galls. The materials were brought fresh into the laboratory and, as soon as possible, before the galls wrinkled up or otherwise became discolored or distorted, photographs were taken (to show the natural appearance of the galls on the parts of the plant attacked), preliminary descriptions made, and specimens saved in a medium of which the following is the formula:

	Parts.
Water	48
95 per cent alcohol	48
40 per cent formaldehyde (formalin)	4

Large-sized homeopathic vials or wide-mouthed dispensing bottles of convenient dimensions and with tight-fitting corks served as preserving vessels. Each bottle or vial had the accession number written on the cork and on the labels that accompanied the specimens in the preserving fluid, the galls and insects being given the same number in the accession record.

Longitudinal and cross sections were made of the mature galls, and these were drawn to show the details in structure and the mechanism peculiar to each case.

No hard and fast rule can be laid down as to the methods to be followed in breeding the insects from their galls. Conditions were different in each case, and laboratory methods had to be modified accordingly. In general, battery jars with fine muslin held on by elastic bands at the top proved to be the best form of breeding receptacle, a decided advantage in favor of these being that the green parts of the plants were kept adequately exposed to the light and that inspection and cleaning were easy. During dry months the materials had to be moistened at least once a day by spraying them with water from a small hand atomizer. Care was taken not to wet the plants too much, for then decay would set in, or the adult insects on emergence would be entrapped by the film of water on the plant surface or the inner wall of the jar and spoiled. The jars were inspected every morning and the adults caught by means of a short test tube. The removal of the adults as soon as they emerged was a necessary measure, because when allowed to stay in the vessel for a longer time many of them would be lost or badly mutilated among the moist plant materials.

Throughout the progress of the work precautions were taken against certain small spiders which, when accidentally introduced into the jar with the plant materials, would prey upon the gall insects as fast as the latter emerged. As a measure against this pest, the pieces of plants were thoroughly shaken, one by one, before being placed into the jars, and a constant watch was kept for the appearance of any of the spiders that might have hatched from eggs accidentally introduced.

Another piece of apparatus used consisted of a light-tight cardboard box with the mouth ends of test tubes or vials inserted into one side. This device was supposed to work on the principle that most insects are attracted to the light; and the interior of the box being dark, except at the insertion of the glass tubes, the insects on emerging were supposed to enter the latter. The apparatus had been used with good results and had been indorsed by the California Board of Horticulture and by the cotton-boll weevil investigators.[9] The results with this device in the present experiments were most disappointing; in almost all trials the adult insects would not readily enter the test tubes, barely 5 per cent of those that emerged in the box having been captured in this manner.

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[9] Banks, Nathan, Directions for Collecting and Preserving Insects, *Bull. U. S. Nat. Mus.* 67 (1909) 115, with figure.

With certain plants artificial breeding in the laboratory was found to be impracticable. The leaves of many species of *Ficus,* for example, dry up in less than an hour after being removed from the tree and placed under ordinary laboratory conditions; when confined in a vessel with a supersaturated atmosphere, decay readily sets in, or the material soon becomes moldy. The same is true with *Astronia* and certain other plants that grow at high altitudes. When the plant was conveniently near the laboratory, the galls were encased in muslin on the tree, so as to prevent the escape of the adults when they emerged; and daily inspection was made of these. However, in the case of the psyllid galls on the leaves of *Ficus ulmifolia* Lam., a badly infested plant of which happened to grow in close proximity to the entomological laboratory, the specimen was left without any cover. On examining the plant, it was found on January 25, 1917, after about two months' daily visits, that some of the galls were newly opened. On that day the plant was visited at frequent intervals, and it was discovered that the newly emerged adults, on growing stronger, had crawled over to the younger and softer tips of the branchlets, where they were easily caught in test tubes. For several days in succession captures were made in this manner.

The thysanopterous gall makers were easily secured from their galls. Provided the galls were not too old, the insects could always be found within in all stages of growth. They were scared out of the galls by gently tapping the latter, and could then be brushed off into a vial of 70 per cent alcohol. The eriophyids were not so easy to secure on account of their habit of clinging fast to the hair tufts of the galls and also because of their exceedingly minute size. Several methods were tried, but the simplest process was to brush the animals onto the surface of a mirror by means of a small camel's-hair brush, and then remove and mount them.

In the attempts to breed the gall insects from their galls, some other specimens—that is, parasites, inquilines, etc.—were often found. At times two or more species of a gall-making family were bred out, and in this case it was not easy to decide which was the gall maker and which the inquiline. There occurred a number of other instances where it was exceedingly difficult to arrive at a definite conclusion as to the real gall maker.

The adult gall insects were kept alive for from six to twelve hours in a cotton-plugged vial in order to give them time to dry and assume their normal color before they were killed. With the exception of the thrips and the eriophyids, two series of preserved specimens were prepared, one on small pins and the other on microscopical slides in Canada balsam or turpentine solution of colophony. If the specimens were scarce, only the former series was made of the adults. The thrips in all instars were always mounted on slides. When plenty of specimens of fresh insect galls could be secured, a number of these were carefully dissected, and the insects in their earlier stages removed and mounted on slides. In the case of transparent specimens, such as the earlier instars of psyllid nymphs and the larvæ of Itonididæ, which would be almost invisible when mounted on slides, resort was had to a previous staining in 0.5 per cent aqueous solution of magenta red for about twenty-four hours.

Drawings of anatomical parts of the gall insects were made with the aid of a camera lucida. Whenever practicable corresponding parts of different species of the same family were drawn to the same scale and in the same position, in order to facilitate comparison. Most of the gall sections were too large to be drawn conveniently by the aid of the microscope and camera lucida, so that practically all the drawings of these materials were made freehand.

RESULTS

Fifty-seven species of galls have been worked with. These are distributed among twenty-six plant families, as follows:

Apocynaceæ, 1.
Araceæ, 1.
Araliaceæ, 2.
Boraginaceæ, 1.
Celastraceæ, 1.
Combretaceæ, 2.
Compositæ, 1.
Dilleniaceæ, 1.
Dipterocarpaceæ, 4.
Euphorbiaceæ, 10.
Guttiferæ, 2.
Hernandiaceæ, 1.
Lauraceæ, 2.
Lecythidaceæ, 1.
Leguminoseæ, 2.
Loganiaceæ, 1.
Melastomataceæ, 2.
Menispermaceæ, 3.
Moraceæ, 7.
Piperaceæ, 1.
Rubiaceæ, 1.
Sapindaceæ, 1.
Tiliaceæ, 2.
Urticaceæ, 1.
Verbenaceæ, 3.
Vitaceæ, 3.

The present work has not been comprehensive enough to warrant our drawing very definite conclusions; but an examination of the above list tends to show that the Euphorbiaceæ have the greatest number of gall-making species, with the Moraceæ ranking second.

Classified as to causes, the following numbers of galls were obtained:

	Species of insects.
Itonidid galls	19
Psyllid galls	7
Thysanopterous galls	7
Eriophyid galls	7
Gelechid galls	1
Miscellaneous galls[a]	16

[a] "Miscellaneous galls" includes all the galls of which the causative agent is not definitely known.

Galls of the insects mentioned in the introductory paragraphs of this paper, other than those of the families enumerated above, have not been met with in the present investigation. Species of Cynipidæ[10] and Tenthredinidæ[11] have been reported from the Philippines, and the chances are that further work will lead to the discovery of the galls of the former, at least. The latter, *Selandria* (*Paraselandria*) *imitatrix* Ashm., according to Prof. C. S. Banks, the collector of the type, is an exophagous species and not a gall maker.

The Aphididæ and the Coccidæ are well represented in the Philippine fauna; but none of their galls have been found in connection with my work. It is not unlikely that their galls can be found here; for in Australia, a country that has many insects closely allied to Philippine species, among the largest and most remarkable galls are produced by some members of these families.[12]

The families Trypetidæ (Diptera) and Buprestidæ (Coleoptera) include many important pests of Philippine economic plants. Their work, however, has not been known to result here in the formation of galls.

In the various excursions made, it was noted that altitude influences the number of species of plant galls to a considerable extent—the galls occurring most abundantly within a belt extending from sea level to an altitude of about 600 meters. Beyond that limit the galls are either very scarce or entirely absent. It was further noted that from sea level to an altitude of about 600 meters the greatest number of species occurred nearer sea level, their abundance diminishing with each 100-meter zone upward. This fact may be ascribed to at least two causes; namely, the prevalence or scarcity of the plant hosts in a given altitudinal zone; and the influence of temperature, moisture, pressure, absence or presence of natural enemies, and possibly other factors on the distribution of gall-making insects in different altitudinal zones. The following is the distribution of gall species, found by me, with respect to altitudes:

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[10] See Kieffer, Nouveaux cynipides des Philippines, *Philip. Journ. Sci.* § D 9 (1914) 183; Neuer Beitrag zur Kenntniss der philippinischen Cynipiden, *Philip. Journ. Sci.* § D 11 (1916) 279.

[11] See Ashmead, Proc. U. S. Nat. Mus. 28 (1905) 971.

[12] Frogatt, Australian Insects (1907) 369, 370, and 380–383.

	Species.
Sea level to 100 meters	36
100 meters to 200 meters	31
200 meters to 300 meters	25
300 meters to 400 meters	23
400 meters to 500 meters	15
500 meters to 600 meters	9
600 meters to 900 meters	1
Above 900 meters	0

In the following pages the galls are divided into groups, according to their causative agents, which are indicated by the center heads; and each species is treated separately, with the specific name of the plant host as a side heading. Accounts of the causal insects, including descriptions of new species, will be given in later publications.

All of the specimen numbers cited in this paper refer to the collection of the department of entomology, College of Agriculture, Los Baños, Laguna, Philippine Islands.

GALLS CAUSED BY ITONIDIDÆ (CECIDOMYIIDÆ)

Acalypha stipulacea Klotz. Euphorbiaceæ.

Leaf galls caused by *Schizomyia acalyphæ* Felt.

Monothalamous; subcylindrical; red; basally yellowish or concolorous with leaf; covered all over with long, stiff, bristle-like hairs. Walls thin, fleshy; interior smooth. Opening apical; covered with a circular flap with edges confluent with the rest of the gall's surface, not visible until a few minutes previous to emergence of midges. Pupal exuviæ often found projecting half way out of opening.

Length of galls, 3.5 to 5.5 millimeters; diameter at base, 1.5 to 2.

On the nether surface of leaf, along principal veins or at points where two small nervules meet.

LUZON, Laguna, College of Agriculture, near lower nursery, Los Baños; at an altitude of about 45 meters. March 15, 1917. Type gall No. 18313, College of Agriculture collection.

Numerous specimens of these galls were found on several young leaves of a small *Acalypha* plant. A part of these materials was confined in Petri dishes. The day following, March 16, 1917, most of the adults emerged. An idea may be had of the habits of the insect during and after emergence from the following notes:

1.40 p. m.—A circular flap gradually separated from the apex of one of the galls, leaving a small part at the circumference attached to the gall. An adult midge, exposed from the pupal exuviæ to about the metathorax, wriggled its way out through the opening until about one-third the length of the exuviæ was exposed. The midge continued to wriggle, this time gradually withdrawing itself from the exuviæ.

1.57 p. m.—Legs completely exposed. With the legs anchored against the outer wall of the gall, the midge continued to struggle with a forward and backward motion, carrying the pupal exuviæ until about two-thirds the total length of the latter were exposed. Finally, with a sudden jerk, the insect completed its emergence.

1.58 p. m.—Wings fully expanded.

2.17 p. m.—Midge able to fly.

Summary.—The midge emerged seventeen minutes after the separation of the lid from the gall was first noted; the wings were fully expanded after another minute; and the insect was able to fly nineteen minutes later.

The galls are apparently scarce, as subsequent excursions resulted in the finding of only one or two isolated specimens.

Antidesma leptocladum Tul. Euphorbiaceæ.

Leaf galls caused by *Ctenodactylomyia antidesmæ* Felt.

Monothalamous; very acutely subconical; red; sometimes basally or wholly concolorous with the leaf; thickly but very briefly pubescent. Apex slightly curved toward one side; very acute. Wall thin; inner layer woody, faintly greenish white; outer, suffrutescent. Chamber following the general shape of the gall. Opening basal; situated at opposite surface of leaf; subcircular, with a close-fitting flap, detachable through the force of the emerging midge.

Length, 8.5 to 10.5 millimeters; diameter at base, 1.5 to 1.75.

On the upper surface of leaf, along the midrib or lateral nervules.

LUZON, Laguna, College of Agriculture, near citrus plantation, Los Baños, at an altitude of about 47 meters; Mount Maquiling, at an altitude of about 250 meters. March and September, 1917. Type gall No. 18157, College of Agriculture collection.

These galls are not very common and their makers are apparently restricted to certain periods of the year, within the dates given above. The leaves dry up in a day or two after being removed from the plant, and it was very difficult to secure the adults.

Barringtonia luzonensis Rolfe. Lecythidaceæ.

Leaf galls caused by *Kronodiplosis uichancoi* Felt.

Monothalamous; spherical; abruptly joined to the leaf by a very short, inconspicuous peduncle; glabrous; very finely punctate; almost concolorous with the leaf. Wall very thick; a thin, outer, succulent layer; the rest hard, ligneous. Chamber about one-tenth the size of the gall; subspherical. Opening subcircular; not visible until after the midge has emerged; without process; usually situated at one side of the gall.

Diameter of gall, 4.5 to 5.5 millimeters.

On nether surface of leaf, usually clustered together in irregular, longitudinal rows with respect to the midrib.

LUZON, Laguna, College of Agriculture, near Students' Campus, Los Baños, at an altitude of about 45 meters; barrio of Lalacay, Los Baños, at an altitude of about 40 meters. February, 1917. Type gall No. 18307, College of Agriculture collection.

These galls are common and are apparently present throughout the year.

Callicarpa erioclona Schauer. Verbenaceæ.

Leaf galls caused by *Asphondylia callicarpæ* Felt.

Polythalamous; consisting of an enlargement of the midrib, which forms with the atrophied leaf lamina a single mass of succulent tissue. Enlarged portion tomentose; concave above and convex on nether surface, petiole and apex usually, and a small portion at base sometimes, normal. Hair long; dark brown; concolorous with the normal short pubescence of the plant. Chambers subellipsoid; size very variable; arranged irregularly in close proximity to upper, concave surface. Opening without process.

Length, about 30 millimeters; width, 15; thickness, 16.

LUZON, Mount Maquiling, at altitudes of from 200 to 300 meters. August, 1917. Type gall No. 18147, College of Agriculture collection.

These galls were very abundant at the altitudes cited. The deformation is confined to the younger, subterminal leaves. Present during the greater part of the year.

Cissus adnata Wall. var. Vitaceæ.

Leaf galls caused by *Hyperdiplosis banksi* Felt.

Monothalamous; subconical; concolorous with leaf; slightly incurved basad; slightly curved subapically laterad; thickly but briefly pubescent. At base, on opposite surface of leaf, gall continued into a slightly raised, broadly subconical structure. Wall thick; succulent. Chamber subcylindrical, concave at base; broader apicad; a thin membranous cover at one-third the length of chamber from apex; inner wall of chamber beneath cover, smooth; above, lined with a thick mat of long hair. Opening apical.

Length, 11 millimeters; diameter at base, 5.5; mean diameter of chamber, 0.5.

On nether surface of leaf; rarely on upper surface.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters. Type gall No. 18306, College of Agriculture collection.

Very numerous on two isolated plants at the place cited; not found elsewhere.

Cissus trifolia (L.) K. Sch. Vitaceæ.

Stem galls caused by *Asphondylia vitea* Felt.

Polythalamous; very irregularly subfusiform or subellipsoid; unevenly tuberculated; consisting of enlargements at various parts of stem; concolorous with, and equally as pubescent as, the normal parts of the stem; succulent. Chambers subellipsoid; embedded irregularly within the succulent tissues of the gall; walls of chambers thin, more or less ligneous. Opening, an irregular tunnel made by the emerging midges through the gall tissues; without process.

Length, 15 to 60 millimeters; diameter, about 10.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of from 45 to 100 meters. August, 1917. Type gall No. 18342, College of Agriculture collection.

These galls were abundant from August to December, 1917, at the altitudes given above. As many as thirty insects have been found to inhabit one gall.

Diplodiscus paniculatus Turcz. Tiliaceæ.

Terminal stem gall caused by *Schizomyia diplodisci* Felt.

Polythalamous; subspherical; prevailing color green with a thin grayish coating; nonpubescent, consisting of enlargements at the ends of lateral branches of the plant. Walls thick; fleshy. Greenish flesh, turning brown after being cut and exposed to air. Chambers ellipsoid; arranged subcentrad in a more or less regular longitudinal bundle with the distal ends closer together than the proximal. Opening not visible until the midges are about ready to emerge; then a crack appears on the distal or lateral area of the gall, depending on the direction toward which the smaller end of the chamber bundle points; an irregular cavity forms thence and connects with the chambers within.

Average diameter of gall, 25.5 millimeters; of chamber, 0.75 to 1 millimeter.

LUZON, Mount Maquiling, at altitudes of 100 to 150 meters. March to August, 1917. Type gall No. 18314, College of Agriculture collection.

Fairly abundant during the months cited. The galls have the general appearance of fruits for which they are very often mistaken.

Grewia stylocarpa Warb. Tiliaceæ.

Leaf galls caused by *Asphondylia grewiæ* Felt.

Monothalamous; abruptly and thinly subreniform; yellowish green, changing to brown at maturity; nonpubescent. Wall thin; somewhat succulent; juice sticky. Chamber conforming with general outline of gall; inner wall smooth. Opening small; subcircular; without process; located at distal margin of gall plate.

Width, 5.5 millimeters; height, 6; thickness, 1.25 to 3.

On the upper surface of the leaf; arranged irregularly face to back in rows along the midrib.

LUZON, Mount Maquiling, at altitudes of 60 to 200 meters. March, 1917. Type gall No. 18137, College of Agriculture collection.

Occasional specimens were found near the trail leading from First Creek to Camp One. The causal midges are very difficult to breed, as the leaves and the galls wrinkle up and dry in less than one day after removal from the plant.

Illigera luzonensis (Presl) Merr. Hernandiaceæ.

Petal galls. Adult midges not collected.

Polythalamous; consisting of abnormal, irregular enlargement of petals; concolorous with corresponding parts of normal flowers; fleshy; nonpubescent. Chambers subellipsoid; embedded in the succulent tissue of the galls. Sepals of flowers affected by the gall abnormally enlarged but not swollen.

Diameter of infested flower, 16.5 millimeters; of normal flower, 4.5.

LUZON, Mount Maquiling, at altitudes of 100 to 300 meters (*C. Mabesa*). September, 1917. Type gall No. 18163, College of Agriculture collection.

Not common.

Leea manillensis Walp. Vitaceæ.

Leaf galls caused by *Lasioptera manilensis* Felt.

Monothalamous; irregularly and elongately subglobose; part of the gall appearing on upper surface of leaf and a corresponding inferior lobe on nether surface. Superior lobe smaller than inferior; the former sometimes flushed with carmine, otherwise uniformly lettuce green throughout; skin smooth, nonpubescent; the original puncture of the ovipositor usually marked by a small, infundibular, eccentric depression. Inferior lobe generally carmine, with a thin lettuce green border; general contour more or less wavy in outline; skin smooth, nonpubescent. Leaf lamina immediately adjoining gall convoluted circumferentially.

Interior fleshy; flesh light green, semitranslucent. Chamber located centrad along longitudinal axis of gall; about three-fourths the length of the gall; curved downward at one end; wall hard but brittle. Opening at inferior lobe; not visible until the midge is ready to emerge, when the part at which the opening should appear becomes darker than the rest of the gall surface; then the opening gradually becomes visible as the circular flap is pushed out.

Length of superior lobe, 7.5 to 9.5 millimeters; width, 5; thickness, 3 to 5; length of inferior lobe, 7 to 9.5; width, 5.5 to 7; thickness, 4 to 5.5.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 150 meters. March, 1917. Type gall No. 18318, College of Agriculture collection.

These galls are apparently abundant during the greater part of the year, especially toward the close of the rainy season.

Mallotus moluccana (L.) Muell.-Arg. Euphorbiaceæ.

Leaf galls. Adult midges not collected.

Monothalamous; subconical; irregularly ribbed longitudinally; sparsely pubescent; light apple green, somewhat paler than leaf. Apex usually obtuse; sometimes produced to a tapering point. A slender projection generally present at opposite surface of leaf. Wall moderately and irregularly thick; succulent. Chamber conforming with general shape of gall. Opening small, circular; located at one side of the gall basad.

Average length, 10 millimeters; diameter, 3.

On the nether surface of the leaf; numerous.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 60 meters. March to September, 1917. Type gall No. 18312, College of Agriculture collection.

These galls are fairly abundant/ Attempts at breeding the causal midges resulted, in all cases, in securing the chalcid parasites only. The causal larvæ found within the galls were typically itonidid larvæ; in all the specimens examined the *spathula sterni* was present. They were invariably parasitized.

Memecylon paniculatum Jack. Melastomataceæ.

Fruit galls. Adult midge not collected.

Infested fruit of irregular shape; more or less compressed proximodistad; pale greenish white, with a slight tinge of yellow; interior yellowish white; succulent. Chambers ellipsoid; numerous; irregularly arranged subcentrad; walls of chambers ligneous.

Average diameter of infested fruit, 16 millimeters.

LUZON, Mount Maquiling, at altitudes of 150 to 500 meters (*Mabesa*). October 15, 1917. Type gall No. 18169, College of Agriculture collection.

Rare.

Pæderia tomentosa Blume. Rubiaceæ.

Leaf galls caused by *Itonida pæderiæ* Felt.

Gall consists of a superior longitudinal infolding of both margins of leaf blade, with a consequent upward curvature of the affected leaf. Abnormal parts extending from base to about one-sixth of the leaf length from apex; the margins touch each other tangentially at sides along midrib. Apical and subapical portion of leaf lamina normal. Chambers formed by infolded parts of leaf thickly lined with long pubescence, the latter serving as support for the developing midges. Midrib and lateral nervules abnormally pubescent at nether surface of leaf. Adult midges make their exit either at distal or at proximal aperture of chambers.

Length of leaf, including petiole, 25 millimeters; length of affected part, about 19; thickness of chamber, from midrib of leaf to distal portion, 6.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. October, 1917. Type gall No. 18165, College of Agriculture collection.

Not very common.

Parashorea plicata Brandis. Dipterocarpaceæ.

Leaf galls, probably caused by *Tricontarinia luzonensis* Felt.[13]

Monothalamous; green when young; castaneous when mature; glabrous; subconical; base somewhat peripherally incurved, the curvature thus formed continuing through the leaf lamina on to the other surface of the leaf and forming the more or less convex bottom of the gall. Apex generally acute; otherwise rounded off. Wall thick; hard and tenacious. Chamber spherical; inclosed by a moderately thick, ligneous wall. A secondary, inferior, subconical, empty chamber; apparently without function.

Diameter at base, 4.5 to 5 millimeters; height, 4 to 6.

On nether surface of leaf; often solitary but sometimes aggregate and fused together.

LUZON, Mount Maquiling, at altitudes of 50 to 500 meters. August, 1917. Type gall No. 18151, College of Agriculture collection.

These galls are fairly common. The leaves, as well as the galls, dry up very quickly when removed from the tree, thereby making it difficult to breed the midges. Further work may lead to the discovery of the actual cause of this interesting formation.

Shorea guiso Blume. Dipterocarpaceæ.

Leaf galls. Adult midges not collected.

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[13] This species is believed by Dr. E. P. Felt to be predacious rather than phytophagous. See Felt, New Philippine gall midges, *Philip. Journ. Sci.* § D **13** (1918) 294.

Monothalamous; spherical; concolorous with leaf; somewhat thickly pubescent. Wall moderately thick; coriaceous. Chamber conforming with the general shape of the gall.

Average diameter, 2.5 millimeters.

On the nether surface of the leaf; submarginal, along principal lateral nervules.

LUZON, Mount Maquiling, at altitudes of 150 to 500 meters. September, 1917, and March, 1918. Type gall No. 18156, College of Agriculture collection.

Galls fairly common. Adult midges could not be obtained, as the leaves and the galls dry up very quickly when removed from the plant.

Siphonodon celastrineus Griff. Celastraceæ.

Leaf galls caused by *Kamptodiplosis reducta* Felt.

Monothalamous; subdiscoid. On upper surface of leaf, as an irregular, raised, subcircular spot, with the leaf cuticle forced open bordering the circumference; dark yellowish brown, more deeply so centrad. On nether surface of leaf, as irregularly raised papules, somewhat paler than leaf; border diffused ectad. Wall thick, ligneous. Chamber discoid. Opening circular, located centrally on the upper surface of the leaf.

Diameter on upper surface, 2.25 millimeters; on nether surface, 4.5; diameter of opening, 0.5 millimeter.

LUZON, Laguna, Balong Bulo Hill, near College of Agriculture, Los Baños, at an altitude of about 60 meters. March, 1917. Type gall No. 18319, College of Agriculture collection.

These galls were found on a single isolated tree. The same tree was visited a year later, and all the galls had disappeared. A search made in other places failed to disclose these galls on plants of the same species.

Spatholobus gyrocarpus (Wall.) Benth. Leguminoseæ.

Leaf galls caused by *Heliodiplosis spatholobi* Felt.

Monothalamous; abruptly and irregularly subconical; rugose; somewhat paler green than leaf; sparsely and briefly pubescent. On nether surface of leaf, subcircular; covered with a dense mat of light green to brown hair. Apex produced in a tapering projection, inclining over on one side. Wall slightly ligneous; thick. Chamber small; discoid. Opening a small, needle-hole-like aperture on nether surface of leaf.

Length of gall, 1.25 to 1.5 millimeters; diameter at base, 3 to 3.5.

On the upper surface of the leaf; very numerous.

LUZON, Mount Maquiling, at altitudes of 100 to 500 meters. July, 1917. Type gall No. 18341, College of Agriculture collection.

These galls are common during the rainy months, and the gall insects are fairly easy to breed out.

Symphorema luzonicum F.-Vill. Verbenaceæ.

Leaf galls caused by *Luzonomyia symphoremæ* Felt.

Monothalamous; spherical or nearly so; stramineous; covered with long, fine, dry, yellowish, nonglandular hairs; more densely pilose proximad than distad; sessile, and with base more or less sunken into the depression formed in the leaf lamina. Wall moderately thick; ligneous; of uniform thickness throughout. Chamber conforming with the general shape of the gall. Opening at distal end of gall; circular; covered with a close-fitting lid, which falls off when the midge emerges.

Diameter of gall, 1.7 to 2 millimeters.

Generally on the nether surface of the leaf; occasionally on the upper surface.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters; Mount Maquiling, at an altitude of 150 to 300 meters. Type gall No. 18315, College of Agriculture collection.

These galls are very common, and the causal midges are often easily bred out. From examination of the younger leaves, it appears that the galls begin with a puncture on either surface of the leaf, surrounded by a conspicuous, semitransparent, diffused area. As the gall grows, the epidermis of the leaf splits open and allows the deformity to continue its development.

Vernonia lancifolia Merr. Compositæ.

Leaf galls caused by *Diceromyia vernoniæ* Felt.

Polythalamous; gall consists of an abnormal contraction and incurving of midrib, with the leaf lamina much wrinkled inferiorly; no abnormal formation of hair or development of differential color. Chambers ovoid or ellipsoid; embedded in the succulent tissues of the abnormal midrib. Openings irregular; situated on concave, upper surface of gall.

Length of gall, 30 millimeters; thickness, 13.

LUZON, Mount Maquiling, at altitudes of 200 to 500 meters. August, 1917. Type gall No. 18143, College of Agriculture collection.

Galls fairly common. Insects easy to breed out.

GALLS CAUSED BY PSYLLIDÆ

Alstonia scholaris R. Br. Apocynaceæ.

Leaf galls[14] caused by *Pauropsylla tuberculata* Crawford.

Monothalamous; subcylindrical; concolorous with leaf, except at apex, yellowish; nonpubescent. Apex somewhat deeply cleft. Wall thick; succulent. Chamber subcuneate, with the sharp edge pointing distad; direction the same as the median depression at cleft of apex. Opening apical; subcircular; without process; not visible until the adult psyllids are ready to emerge. On the opposite surface of the leaf, a short, conical protuberance with apex broadly rounded.

Average length, 4 millimeters; broader diameter at apex, 3; narrower, 2.5; broader diameter at base, 3.75; narrower, 3.

On either surface of the leaf; more commonly on nether surface.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 50 meters. May, 1917. Gall No. 18322, College of Agriculture collection.

These galls are abundant but the adult insects are somewhat difficult to rear on account of the tendency of the leaves to dry in a couple of days after removal from the tree. The causal psyllid was first described from Pusa, Bengal, and reported as captured on *Alstonia* and also on "pumpkin."[15] The insect has never been recorded from the Philippines before.

Calophyllum inophyllum L. Guttiferæ.

Leaf galls. Adult psyllids collected but not identified.

One or both margins of leaf, except at apex and base, narrowly doubled up inferiorly, the fold forming the chamber wherein the insect passes its preimaginal stages. Older leaves more deeply concave longitudinally; a slight yellowing at different places on the folds.

Average diameter of fold, 2.5 millimeters.

LUZON, Laguna, School of Forestry, Los Baños, at an altitude of about 100 meters. March, 1918. Type gall No. 18348, College of Agriculture collection.

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[14] Previously described by Rübsaamen from Bismarck Archipelago in Marcellia 4 (1905) 7. Also described and figured by Leeuwen-Reijnvaan from Java in Marcellia 9 (1910) 38. Figured by Leeuwen-Reijnvaan in Bull. Jard. Bot. Buitenzorg, II 3 (1912) 4. Described by Leeuwen-Reijnvaan from Celebes, Bull. Jard. Bot. Buitenzorg II 21 (1916) 24.

[15] Crawford, Indian Psyllidæ, *Rec. Ind. Mus.* 7 (1912) 430.

Galls common in the place cited; not found on the same plant elsewhere in Los Baños. Adults found only on March 11, 1918, after about one year's occasional observation on the nymphs within the galls.

Ficus nervosa Heyne. Moraceæ.

Leaf galls caused by *Dinopsylla cornuta* Crawford.

Fresh galls of these insects have never been obtained by me. A single infested leaf that had fallen from the tree was found; but the galls were too badly mutilated and shriveled up to furnish adequate material for description. Prof. C. F. Baker had previously bred this *Dinopsylla* from the same galls, and is my authority for the identity of the insect and its work. *Ficus nervosa* Hey. is fairly common in Mount Maquiling, at altitudes of 100 to 150 meters.

Ficus ulmifolia Lam. Moraceæ.

Leaf galls No. 1, caused by *Pauropsylla deflexa* sp. nov. (MS).

Monothalamous; very abruptly and irregularly subconical; lettuce green, lighter in color than leaf; pubescent, more thickly so than leaf. Apex usually obtuse; sometimes abruptly pointed. Bottom, at opposite side of leaf, subhemispherical; concolorous with and equally as pubescent as the rest of the gall. Chamber elongately subellipsoid; lining smooth. Wall thick; succulent. Opening apical; not visible until adults are ready to emerge; then wall splits open longitudinally from apex subbasad into several irregular lobes; each lobe deflected ectad.

Average length, 6 millimeters; diameter, 5; length of chamber, 3.5; diameter, 1.25.

Subconical portion on nether surface of leaf; subhemispherical, on upper surface. Usually aggregate and fused together, giving appearance of polythalamous galls.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 42 meters. January, 1917. Type gall No. 18309, College of Agriculture collection.

These galls are very common, but the adults are very difficult to breed. The leaves dry in less than half a day after removal from the tree. Numerous adult psyllids emerged from galls on a small *Ficus* tree in the nursery of the college, and were collected from the young shoots, up which the insects had crawled to feed.

Ficus ulmifolia Lam. var. Moraceæ.

Leaf galls No. 2. Adult psyllids not found.

Monothalamous; subconical; slightly curved subapicad toward one side; orange to red. Surface scabrous; nonpubescent; somewhat shiny. Wall moderately thick; succulent. Chamber conforming with the general shape of the gall; a tiny raised tubercle centrad at bottom.

Average length, 7.5 millimeters; diameter at base, 4.

On the upper surface of the leaf; usually solitary; occasionally aggregate, but only partially fused together and the individual galls are distinguishable.

LUZON, Mount Maquiling, at an altitude of 150 meters. March 16, 1918. Type gall No. 18401, College of Agriculture collection.

Apparently rare.

Ficus variegata Blume. Moraceæ.

Leaf galls caused by *Pauropsylla montana* sp. nov. (MS).

Monothalamous; subspherical; paler green than leaf; covered all over with long, succulent, slightly pubescent spines. A tiny, abrupt, acutely subconical projection centrad at bottom of gall on opposite surface of leaf. Wall thin; succulent. Chamber subspherical; abruptly produced obconically at bottom. Opening apical; not visible until adult is ready to emerge; then wall splits from apex longitudinally subbasad into usually five irregular lobes; each lobe deflected ectad.

Average diameter, 5 millimeters.

On the upper surface of the leaf; numerous; sometimes connivent, but never fused.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters; Mount Maquiling, at altitudes of 70 to 150 meters. January, 1917. Type gall No. 18310, College of Agriculture collection.

Galls fairly common; insects easy to breed.

Mallotus philippensis (Lam.) Muell.-Arg. Euphorbiaceæ.

Leaf galls caused by *Megatrioza pallida* sp. nov. (MS).

Shallow, concave depressions on nether surface of leaf, with the upper surface correspondingly convex. No abnormal growth of hair. Apex on concave surface yellowish to reddish brown; the rest unicolorous with leaf. Nymph fits in snugly on concave surface, the insect establishing itself there until ready to emerge.

Average diameter, 2 millimeters; average depth of concavity, 0.5.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters. January, 1918. Type gall No. 18174, College of Agriculture collection.

Galls very common; insects observed in the adult stage only in January.

GALLS CAUSED BY THYSANOPTERA

Dillenia reifferscheidia F.-Vill. Dilleniaceæ.

Leaf galls. Causal thrips collected but not identified.

Leaf margins wholly or partially involute toward nether surface of leaf; when partially so, the involution usually extends from apex, leaving a basal fraction of the leaf unaffected. Minute, red, irregular, hard papules more prominent on upper surface or at the continuation of the latter in the roll than on nether surface. Thrips in different stages found within the rolls of younger leaves.

Average diameter of roll, 8 millimeters.

LUZON, Laguna, College of Agriculture, lower nursery, Los Baños, at an altitude of about 43 meters. October, 1917. Type gall No. 18158, College of Agriculture collection.

These galls are apparently confined to a single isolated tree at the bank of Molauin Creek in the place cited. None of these materials was found elsewhere.

Ficus ulmifolia Lam. Moraceæ.

Leaf galls caused by *Gigantothrips elegans* Zimmerman.[16]

Part of leaf margin involuted or deflected. Small, irregular, reddish dots, bounded by irregular, yellow areas, visible on both surfaces. Insects found on nether surface of leaf.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. January, 1918. Gall No. 18403, College of Agriculture collection.

These galls are abundant during the greater part of the year.

Garcinia venulosa (Blanco) Choisy. Guttiferæ.

Leaf galls. Thrips collected but not identified.

Open; a carinate structure formed by the superior involution of a part of submarginal portion of leaf; paler green than leaf;

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[16] The insect has been reported from Java as making similar galls on the leaves of various other species of *Ficus*. See Leeuwen-Reijnvaan, Beitrage zur Kenntniss der Gallen von Java, Pt. V, *Bull. Jard. Bot. Buitenzorg* II 10 (1913).

nonpubescent. Wall thicker than leaf lamina; slightly rugose on both outer and inner surfaces. Opening, a longitudinal slit on nether surface.

Length, 60 millimeters; height, 5.5; thickness, 1.75.

On the upper surface of the leaf; solitary.

LUZON, Mount Maquiling, at an altitude of about 150 meters. March 16, 1918. Type gall No. 18402, College of Agriculture collection.

Apparently rare.

Mallotus philippensis (Lam.) Muell.-Arg. Euphorbiaceæ.

Leaf galls caused by *Neoheegeria mendax* Karny.[17]

Terminal and subterminal leaves with laminæ irregularly connivent superiorly; much wrinkled and aborted. Folds produced by wrinkles, pale lettuce green. Insects found between the apposing leaf blades.

Average length (wrinkled), 20 millimeters.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 47 meters. January, 1918. Gall No. 18175, College of Agriculture collection.

Fairly common.

Piper loheri C. DC. Piperaceæ.

Leaf galls caused by *Gynaikothrips chavicæ* Zimmerman.[18]

Irregular, roughened, pale greenish white depressions through leaf lamina, the concavity being on the upper surface; a corresponding convex portion on nether surface of leaf. Depressions more numerous submarginally apicad, and the margins at this portion of leaf involuted superiorly. Thrips found in depressions of younger leaves.

Average diameter of depressions, 2 millimeters.

LUZON, Laguna, College of Agriculture, Los Baños, at altitudes of 45 to 100 meters. October, 1917. Gall No. 18160, College of Agriculture collection.

Galls very common throughout the year.

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[17] Gall and insect previously described from Java. See Karny, Gallenbewohnende Thysanopteren aus Java, *Marcellia* 11 (1912) 122. Karny and Leeuwen-Reijnvaan, Über die javanischen Thysanopteren und deren Bewohner, *Bull. Jard. Bot. Buitenzorg* II 10 (1913) 10 and 64.

[18] Previously reported from Java, Sumatra, and Celebes by Leeuwen-Reijnvaan as making galls on other species of *Piper*. See Marcellia 8 (1909) 113; Bull. Jard. Bot. Buitenzorg 10 (1913) 17, 21 (1916) 17 and 38.

Raphidophora perkinsiæ Engl. Araceæ.

Leaf galls. Thrips collected but not identified.

One or both margins of leaf inferiorly involuted; the rolls extending from base nearly to apex; rolls nearly meeting each other along midrib. Irregular, yellowish, convoluted markings visible from both surfaces.

Diameter of rolls, 4.5 millimeters.

LUZON, Mount Maquiling, at altitudes of 70 to 150 meters. October, 1917, and March, 1918. Type gall No. 18167, College of Agriculture collection.

Not very common.

Schefflera odorata (Blanco) Merr. et Rolfe. Araliaceæ.

Leaf galls [19] caused by *Gynaikothrips chavicæ* var. *heptapleuri* Karny.

Irregularly subcylindrical to subfusiform; elongate; noticeably curved at certain points, especially so subapicad; slightly paler green than leaf; somewhat rugose; nonpubescent. Wall not much thicker than leaf; succulent. Interior irregularly blotched with brownish markings. Opening subcircular; uncovered.

Average length of gall, 18 millimeters; diameter at largest point, 3.5; diameter of opening, 1.5.

On the upper surface of the leaf; numerous.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 45 meters. May, 1917. Gall No. 18136, College of Agriculture collection.

Not very common.

GALLS CAUSED BY GELECHIDÆ

Glochidion album (Blanco) Boerl. Euphorbiaceæ.

Leaf galls. Adult collected but not identified.

Monothalamous; subreniform; purplish red to reddish brown; basally concolorous with leaf; covered all over with short, stout pubescence. Wall thick; succulent; thicker distad than proximad. Chamber subfusiform; bottom broadly convex; one end produced into a long neck; neck guarded externally by a thin epidermis, concolorous and confluent with the rest of the outer gall surface until shortly before emergence of adult. A thin, whitish, membranous secondary flap near base of neck. Opening subcircular; at one end of gall.

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[19] Previously reported by Leeuwen-Reijnvaan from Java; see Bull. Jard. Bot. Buitenzorg II 3 (1912) 29.

Also, from Sumatra and Simaloer, and Celebes; see Bull. Jard. Bot. Buitenzorg II 21 (1916) 10 and 32.

Length of gall, 11.5 millimeters; thickness, 5.75; breadth, 4.5; length of chamber, including neck, 9.25; diameter at broadest point, 2.5.

On upper surface of leaf; numerous.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters (*Baker and Uichanco*); Mount Maquiling, at an altitude of about 150 meters. January, 1917. Type gall No. 18308, College of Agriculture collection.

Fairly common; but adults difficult to breed.

ERIOPHYID AND MISCELLANEOUS GALLS

The part of this treatise, involving galls caused by Eriophyidæ, is withdrawn for a later paper. Likewise, all other galls of which the insects have not been found are omitted here in the hope that further work on additional fresh materials, which are constantly coming in, may furnish some clue to the identity of the causative agents.

ACKNOWLEDGMENTS

I wish to express my hearty appreciation of the valuable assistance given me by Prof. Charles Fuller Baker, acting dean of the College of Agriculture, and Prof. Charles S. Banks, chief of the department of entomology, under whose joint direction the work was conducted. The work was begun under Professor Baker while Professor Banks was in America. I am also under great obligation to Prof. F. W. Foxworthy and Messrs. Calixto Mabesa and Nemesio Catalan, of the department of dendrology (forest botany), School of Forestry, for identification of most of the botanical material and for their kindly coöperation; to Prof. E. D. Merrill, botanist of the Bureau of Science, for identification of some botanical specimens; to Dr. E. P. Felt, state entomologist, Albany, New York, U. S. A., for determination of gall midges collected from my galls; and to Dr. W. Docters van Leeuwen-Reijvaan of Bandoeng, Java, for having very kindly furnished me with an almost complete set of his important papers on Dutch East Indian galls.

ILLUSTRATIONS

PLATE I

FIG. 1. *Acalypha stipulacea* Klotz. Leaf gall caused by *Schizomyia acalyphæ.* Longitudinal median section. × 5.

2. *Barringtonia luzonensis* Rolfe. Leaf gall caused by *Kronodiplosis uichancoi* Felt. Longitudinal median section. × 8.
3. *Antidesma leptocladum* Tul. Leaf gall caused by *Ctenodactylomyia antidesmæ* Felt. Longitudinal median section. × 5.
4. *Callicarpa erioclona* Schauer. Leaf gall caused by *Asphondylia callicarpæ* Felt. Longitudinal median section. × 2.5.
5. *Cissus trifolia* (L.) K. Sch. Stem gall caused by *Asphondylia vitea* Felt. Longitudinal median section. × 2.
6. *Cissus adnata* Wall. var. Leaf gall caused by *Hyperdiplosis banksi* Felt. Longitudinal median section. × 5.
7. The gall shown in fig. 6. Cross section near the base. × 5.

PLATE II

FIG. 1. *Pæderia tomentosa* Blume. Leaf gall caused by *Itonida pæderiæ* Felt. Cross section. × 7.5.

2. *Parashorea plicata* Brandis. Leaf gall probably caused by *Tricontarinia luzonensis* Felt. Longitudinal median section. × 7.5.
3. *Leea manillensis* Walp. Leaf gall caused by *Lasioptera manilensis* Felt. Longitudinal median section. × 6.
4. *Diplodiscus paniculatus* Turcz. Terminal stem gall caused by *Schizomyia diplodisci* Felt. Longitudinal median section. × 2.
5. The gall shown in fig. 4. Cross section. × 2.
6. The gall shown in fig. 1. Longitudinal median section. × 3.

PLATE III

FIG. 1. *Symphorema luzonicum* F.-Vill. Leaf gall caused by *Luzonomyia symphoremæ* Felt. Distal aspect, with lid removed to show opening. × 22.5.

2. The gall shown in fig. 1. Longitudinal median section. × 22.5.
3. The gall shown in fig. 1. Lid, ectal aspect. × 22.5.
4. The gall shown in fig. 1. Lid, ental aspect. × 22.5.

PLATE IV

FIG. 1. *Spatholobus gyrocarpus* (Wall.) Benth. Leaf gall caused by *Heliodiplosis spatholobi* Felt. Longitudinal median section. × 20.

2. *Glochidion album* (Blanco) Boerl. Leaf gall. Longitudinal median section. × 5.
3. The gall shown in Plate VI, fig. 3. Cross section. × 20.
4. *Vernonia lancifolia* Merr. Leaf gall caused by *Diceroyia vernoniæ* Felt. Longitudinal median section. × 2.
5. *Mallotus moluccana* (L.) Muell.-Arg. Leaf gall. Longitudinal median section. × 5.
6. *Siphonodon celastrineus* Griff. Leaf gall caused by *Kamptodiplosis reducta* Felt. Longitudinal median section. × 20.

PLATE V

FIG. 1. *Alstonia scholaris* R. Br. Leaf gall caused by *Pauropsylla tuberculata* Crawford. Longitudinal median section in the direction of the apical cleft. × 20.

2. The gall shown in fig. 1. Section across the apical cleft. × 20.

3. *Mallotus philippensis* (Lam.) Muell.-Arg. Leaf gall caused by *Megatrioza pallida* sp. nov. (MS). Longitudinal median section. × 20.

PLATE VI

FIG. 1. *Ficus ulmifolia* Lam. Leaf gall caused by *Pauropsylla deflexa* sp. nov. (MS). Longitudinal median section. × 5.

2. *Ficus variegata* Blume. Leaf gall caused by *Pauropsylla montana* sp. nov. (MS). Open, after emergence of adult. Distal aspect. × 5.

3. *Schefflera odorata* (Blanco) Merr. and Rolfe. Leaf gall caused by *Gynaikothrips chavicæ* var. *heptapleuri* Karny. Longitudinal median section. × 5.

4. The gall shown in fig. 2. Spine from exterior wall. × 130.

5. The gall shown in fig. 2. Longitudinal median section. × 7.5.

6. *Dillenia reifferscheidia* F.-Vill. Leaf gall. Section across leaf. × 7.5.

PLATE VII

FIG. 1. Old galls of the species illustrated in fig. 3, showing openings through which the adults escaped. View from nether surface of leaf. × 1.5.

2. *Grewia stylocarpa* Warb. Leaf galls caused by *Asphondylia grewiæ* Felt. View from upper surface of the leaf. × 1.

3. *Barringtonia luzonensis* Rolfe. Young or nearly mature, unopened leaf galls, caused by *Kronodiplosis uichancoi* Felt. View from nether surface of leaf. × 1.5.

4. *Parashorea plicata* Brandis. Leaf galls, probably caused by *Tricontarinia luzonensis* Felt. View from nether surface of leaf. × 1.5.

PLATE VIII

FIG. 1. *Diplodiscus paniculatus* Turcz. Terminal stem gall caused by *Schizomyia diplodisci* Felt. Nearly mature specimen, without crevice. × 1.5.

2. The gall shown in fig. 1. Old specimen, showing crevice through which adults escaped. × 1.5.

3. *Acalypha stipulacea* Klotz. Leaf galls caused by *Schizomyia acalyphæ* Felt. View from nether surface of leaf. × 1.5.

4. *Cissus trifolia* (L.) K. Sch. Stem gall caused by *Asphondylia vitea* Felt. Type 1. × 1.5.

5. *Pæderia tomentosa* Blume. Leaf gall caused by *Itonida pæderiæ* Felt. Lateral view. × 1.5.

6. The gall shown in fig. 4. Type 2. × 1.5.

7. *Cissus adnata* Wall. var. Leaf galls caused by *Hyperdiplosis banksi* Felt. View from nether surface of leaf. × 1.

PLATE IX

FIG. 1. *Leea manillensis* Walp. Leaf galls caused by *Lasioptera manilensis* Felt. Superior lobes on upper surface of leaf. × 1.5.

2. The gall shown in fig. 1. Inferior lobes on nether surface of leaf. × 1.5.

3. The gall shown in Plate X, fig. 1. View from nether surface of leaf. × 1.5.

4. *Antidesma leptocladum* Tul. Leaf galls caused by *Ctenodactylomyia antidesmæ* Felt. View from upper surface of leaf. × 1.5.

5. *Symphorema luzonicum* F.-Vill. Leaf galls caused by *Luzonomyia symphoremæ* Felt. Young or nearly mature, unopened specimens. View from nether surface of leaf. × 1.5.

6. The gall shown in fig. 5. View from upper surface of leaf, showing depressions formed by galls at opposite surface. × 1.5.

7. The gall shown in fig. 5. Old specimens, showing circular openings distad, through which the adults escaped. View from nether surface of leaf. × 1.5.

PLATE X

FIG. 1. *Spatholobus gyrocarpus* (Wall.) Benth. Leaf galls caused by *Heliodiplosis spatholobi* Felt. View from upper surface of leaf. × 1.5.

2. *Callicarpa erioclona* Schauer. Leaf gall caused by *Asphondylia callicarpæ* Felt. Superior aspect. × 1.5.

3. *Vernonia lancifolia* Merr. Leaf galls caused by *Diceromyia verniæ* Felt. × 1.5.

4. The gall shown in fig. 3. Longitudinal median section, showing larval chambers. × 1.

PLATE XI

FIG. 1. *Mallotus moluccana* (L.) Muell.-Arg. Leaf galls. Type 1, with acute apices. View from nether surface of leaf. × 1.

2. The gall shown in fig. 1. Type 2, with obtuse apices. × 1.5.

3. The gall shown in fig. 1. View from upper surface of leaf, showing long, slender projections at bottom of galls. × 1.5.

4. *Siphonodon celastrineus* Griff. Leaf galls caused by *Kamptodiplosis reducta* Felt. View from upper surface of leaf. × 1.5.

PLATE XII

FIG. 1. *Ficus ulmifolia* Lam. Leaf galls, No. 1, caused by *Pauropsylla deflexa* sp. nov. (MS). Old specimens, showing openings through which the adults escaped. View from nether surface of leaf. × 1.5.

2. *Alstonia scholaris* R. Br. Leaf galls caused by *Pauropsylla tuberculata* Crawford. View from upper surface of leaf, showing bottoms of galls. × 1.5.

3. The galls shown in fig. 2. View from nether surface of leaf. × 1.5.

4. ***Ficus ulmifolia*** **Lam.** Leaf galls No. 2. Young or nearly mature galls. View from upper surface of leaf. × 1.5.

5. The galls shown in fig. 1. Superior lobes on upper surface of leaf. × 1.5.
6. The galls shown in fig. 1. Inferior lobes on nether surface of leaf. × 1.5.

PLATE XIII

FIG. 1. *Ficus variegata* Blume. Leaf galls caused by *Pauropsylla montana* sp. nov. (MS). Closed, before emergence of adults; open, after emergence. View from upper surface of leaf. × 1.
2. *Mallotus philippensis* (Lam.) Muell.-Arg. Leaf galls caused by *Megatrioza pallida* sp. nov. (MS). View from upper surface of leaf. × 1.5.
3. The galls shown in fig. 2. View from nether surface of leaf. × 1.5.
4. *Calophyllum inophyllum* Linn. Marginal leaf gall. View from nether surface of leaf. × 1.5.

PLATE XIV

FIG. 1. *Dillenia reifferscheidia* F.-Vill. Leaf galls. View from nether surface of leaf. The seven subhemispherical, white bodies along the midrib of the leaf are coccids, which have been accidentally introduced in the picture. They have absolutely nothing to do with the formation of the galls. ×1.5.
2. *Mallotus philippensis* (Lam.) Muell.-Arg. Leaf galls caused by *Neoheegeria mendax* Karny. × 1.5.
3. *Ficus ulmifolia* Lam. Leaf galls caused by *Gigantothrips elegans* Zimmerman. Lateral view. × 1.5.
4. *Garcinia venulosa* Lam. Leaf galls. View from upper surface of leaf. × 1.5.

PLATE XV

FIG. 1. *Glochidion album* (Blanco) Merr. Leaf galls caused by Gelechidæ. View from nether surface of leaf. × 1.
2. The gall shown in fig. 1. View from upper surface of leaf. × 1.
3. *Raphidophora perkinsiæ* Engl. Leaf galls. Proximal portion of leaf. × 1.5.
4. The gall shown in fig. 3. Distal portion of leaf. × 1.5.
5. *Schefflera odorata* (Blanco) Merr. and Rolfe. Leaf galls caused by *Gynaikothrips chavicæ* var. *heptapleuri* Karny. View from upper surface of leaf. × 1.5.
6. The galls shown in fig. 5. View from nether surface of leaf, showing openings of the galls. × 1.5.
7. *Piper loheri* C. DC. Leaf galls caused by *Gynaikothrips chavicæ* Zimmerman. View from upper surface of leaf; nether surface of leaf exposed at rolled-up margin. × 1.5.

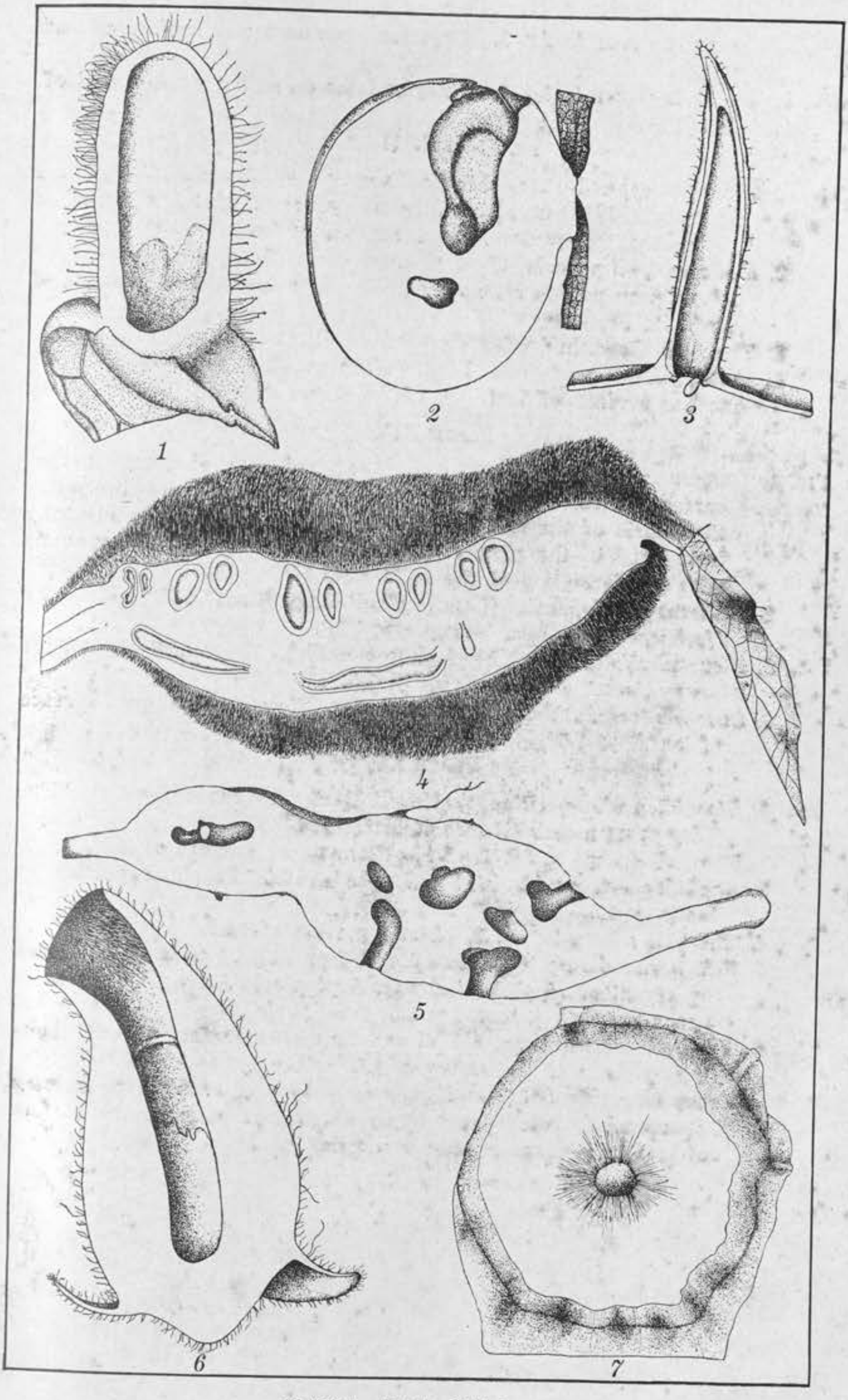
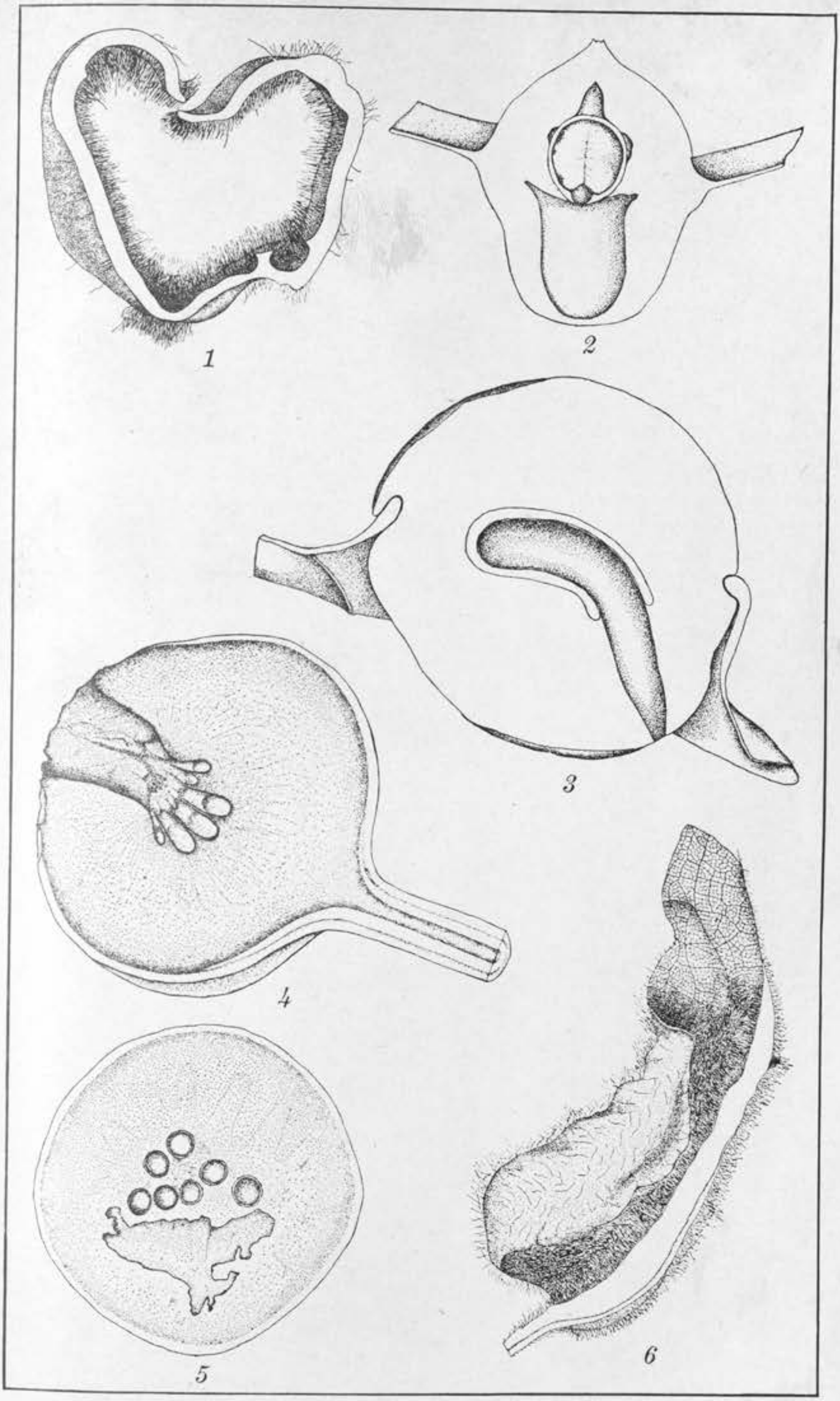


PLATE I. PLANT GALLS.



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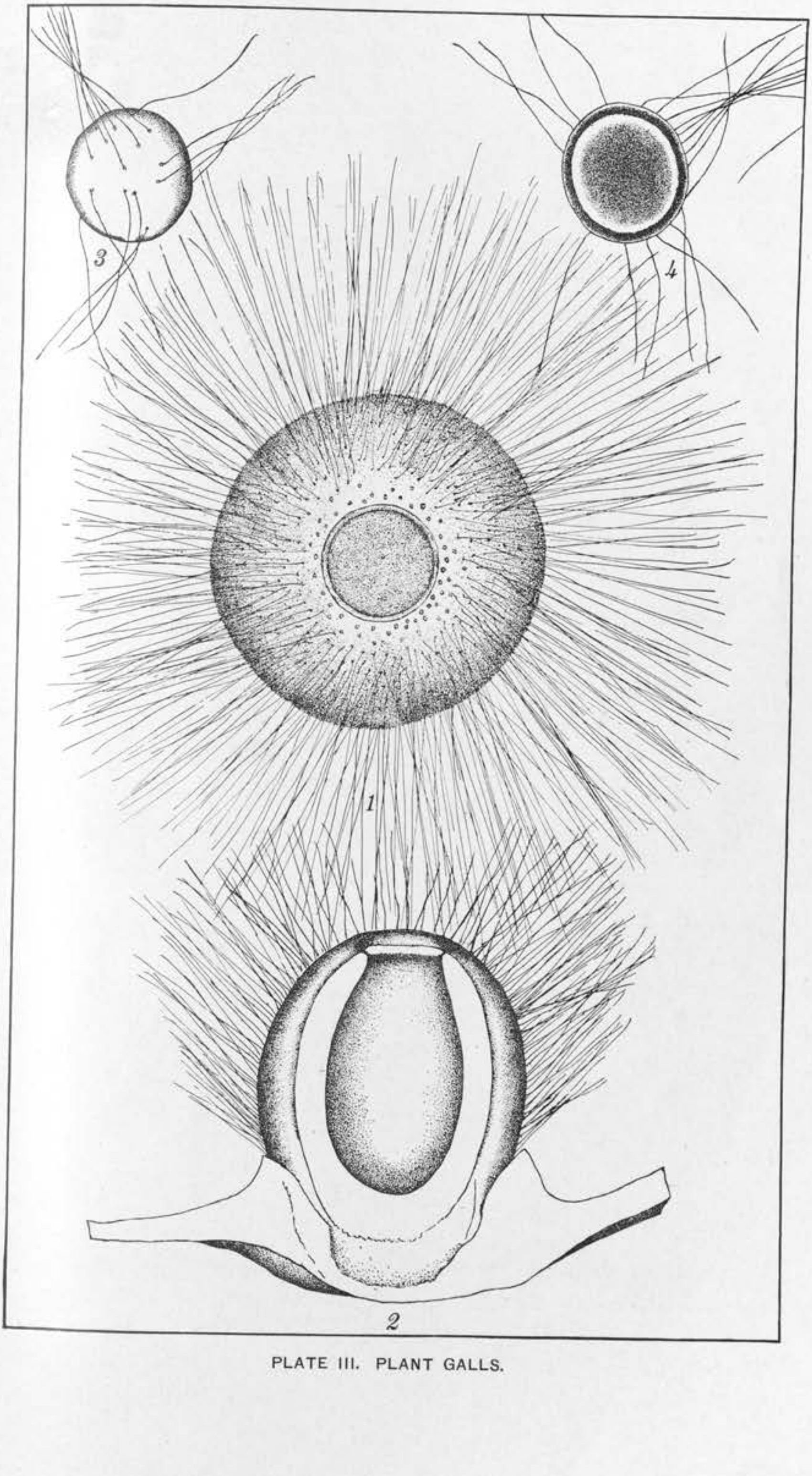

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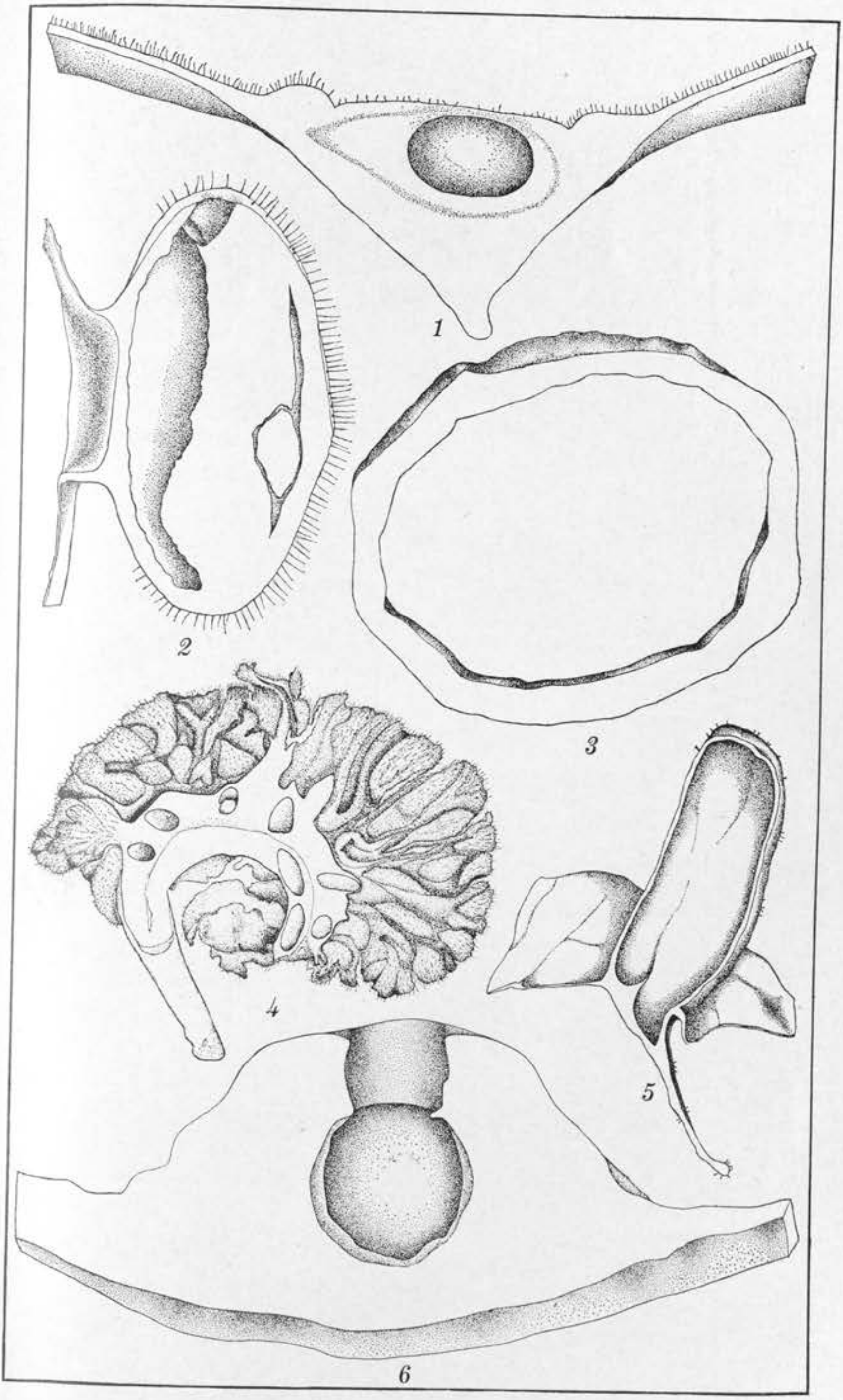
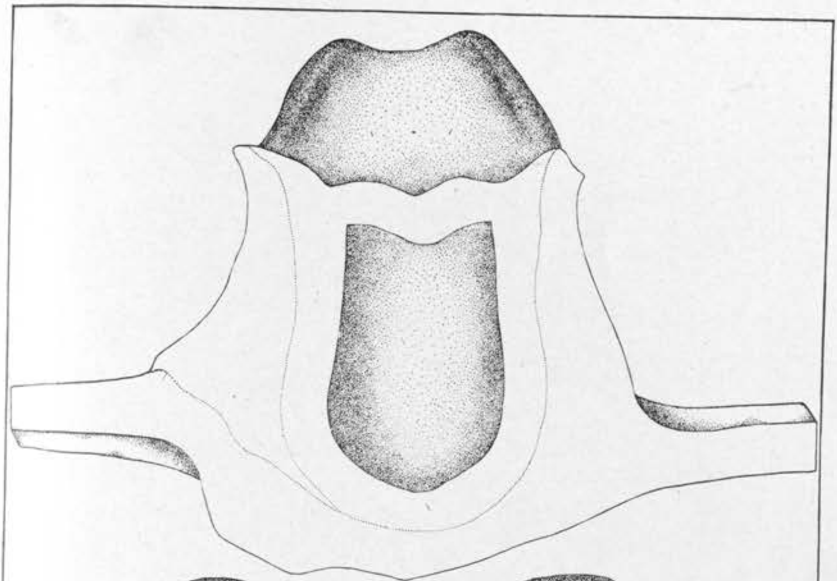


PLATE IV. PLANT GALLS.



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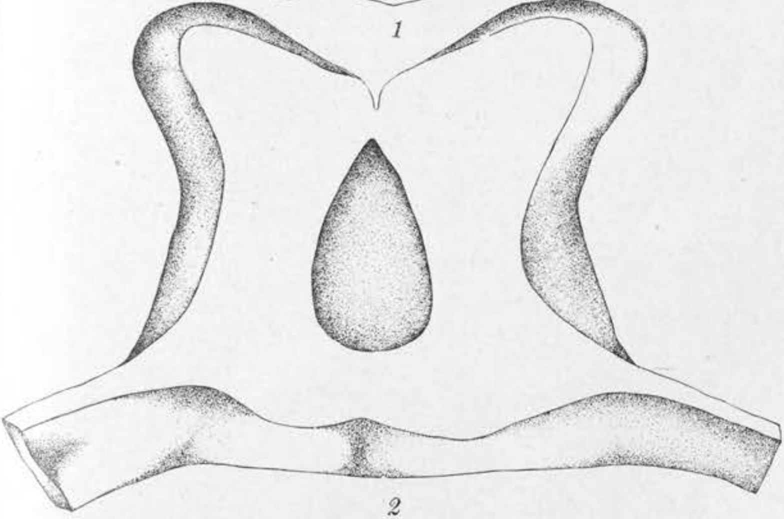

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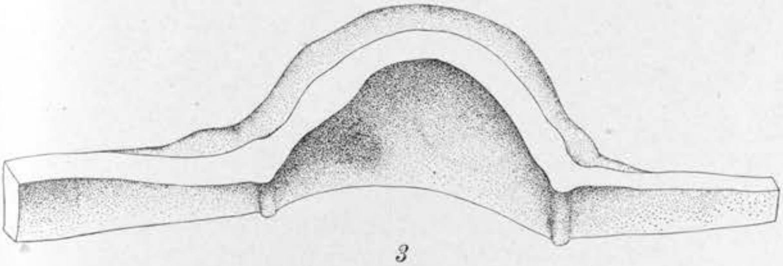

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PLATE V. PLANT GALLS.

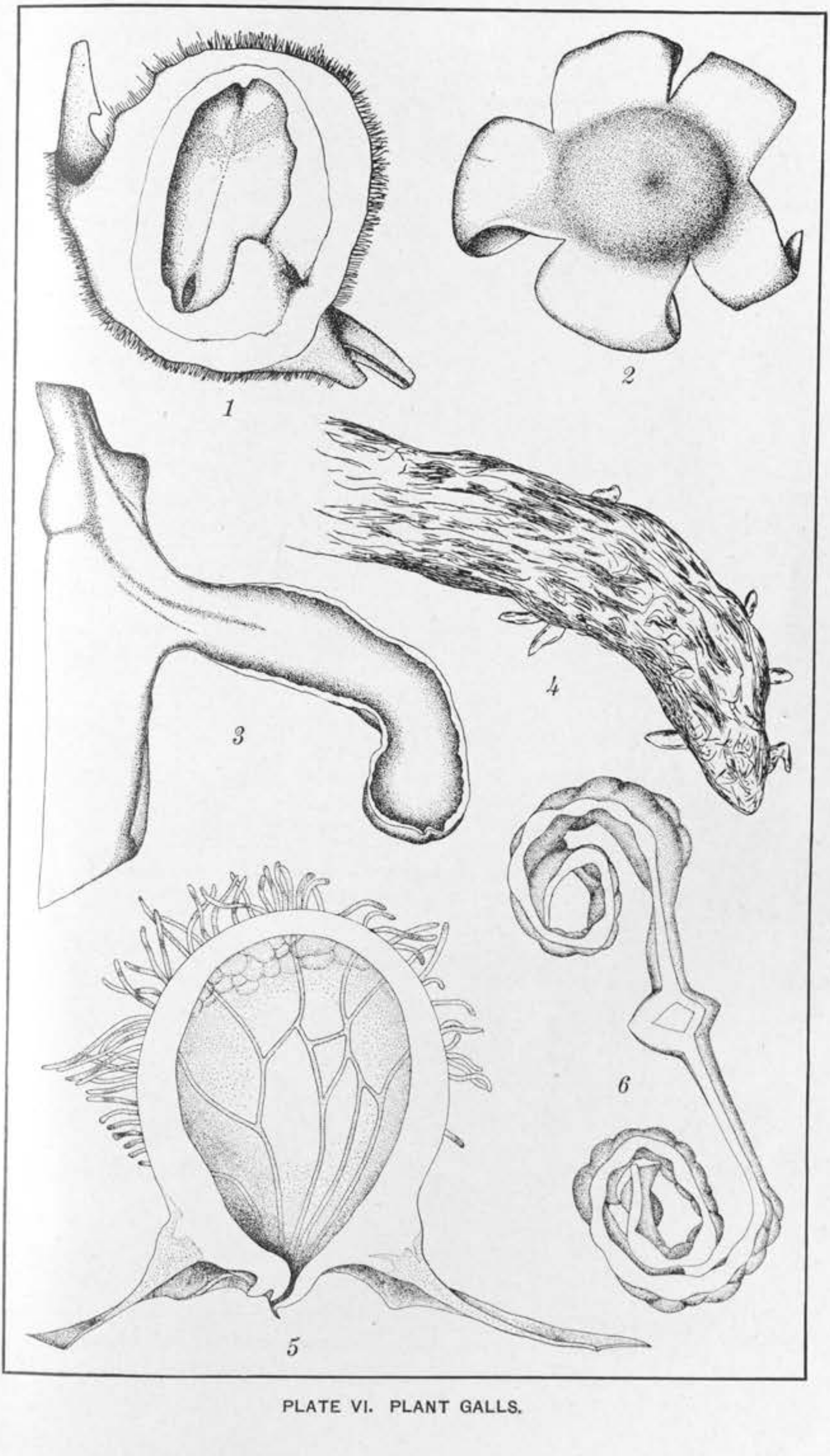


PLATE VI. PLANT GALLS.

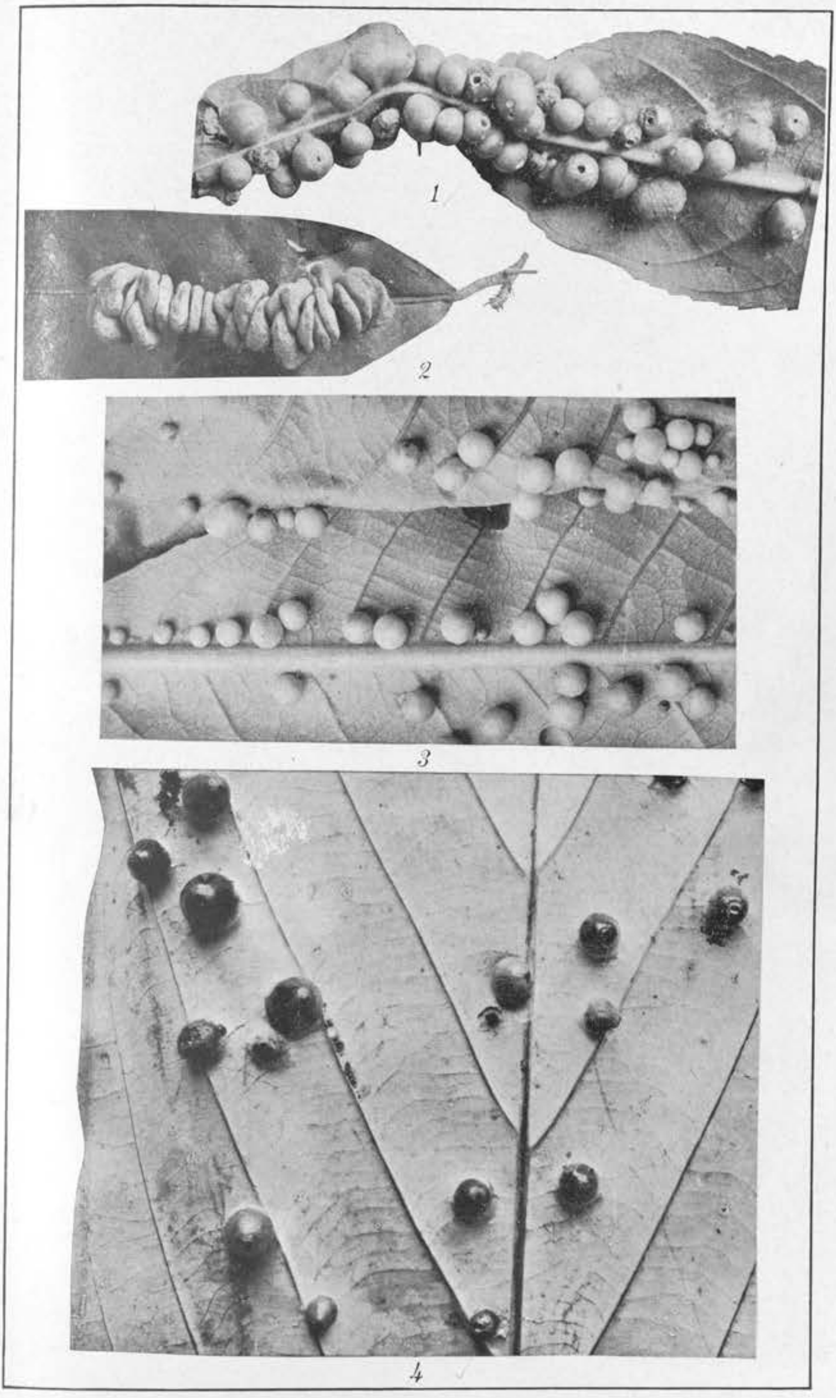


PLATE VII. PLANT GALLS.

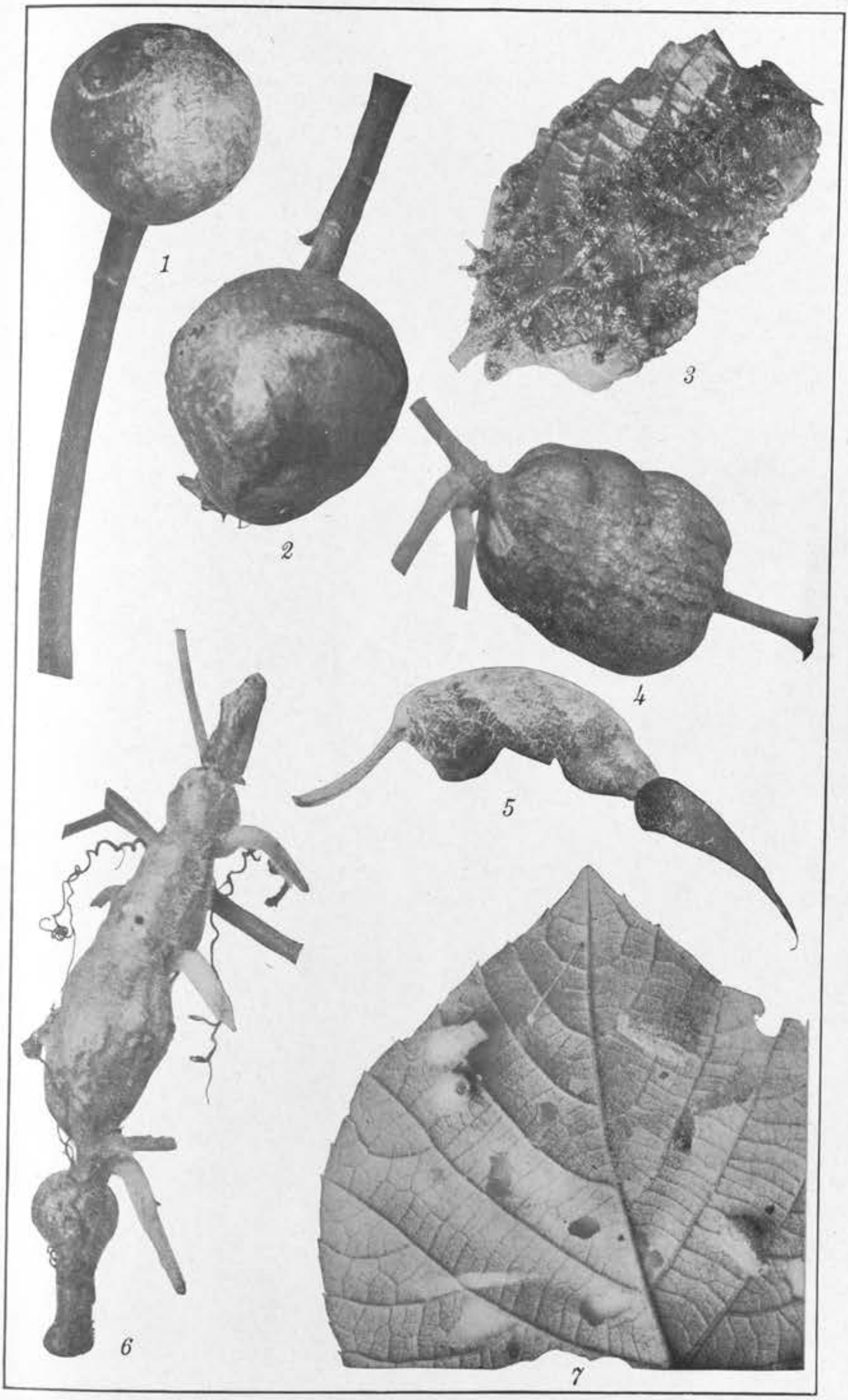


PLATE VIII. PLANT GALLS.

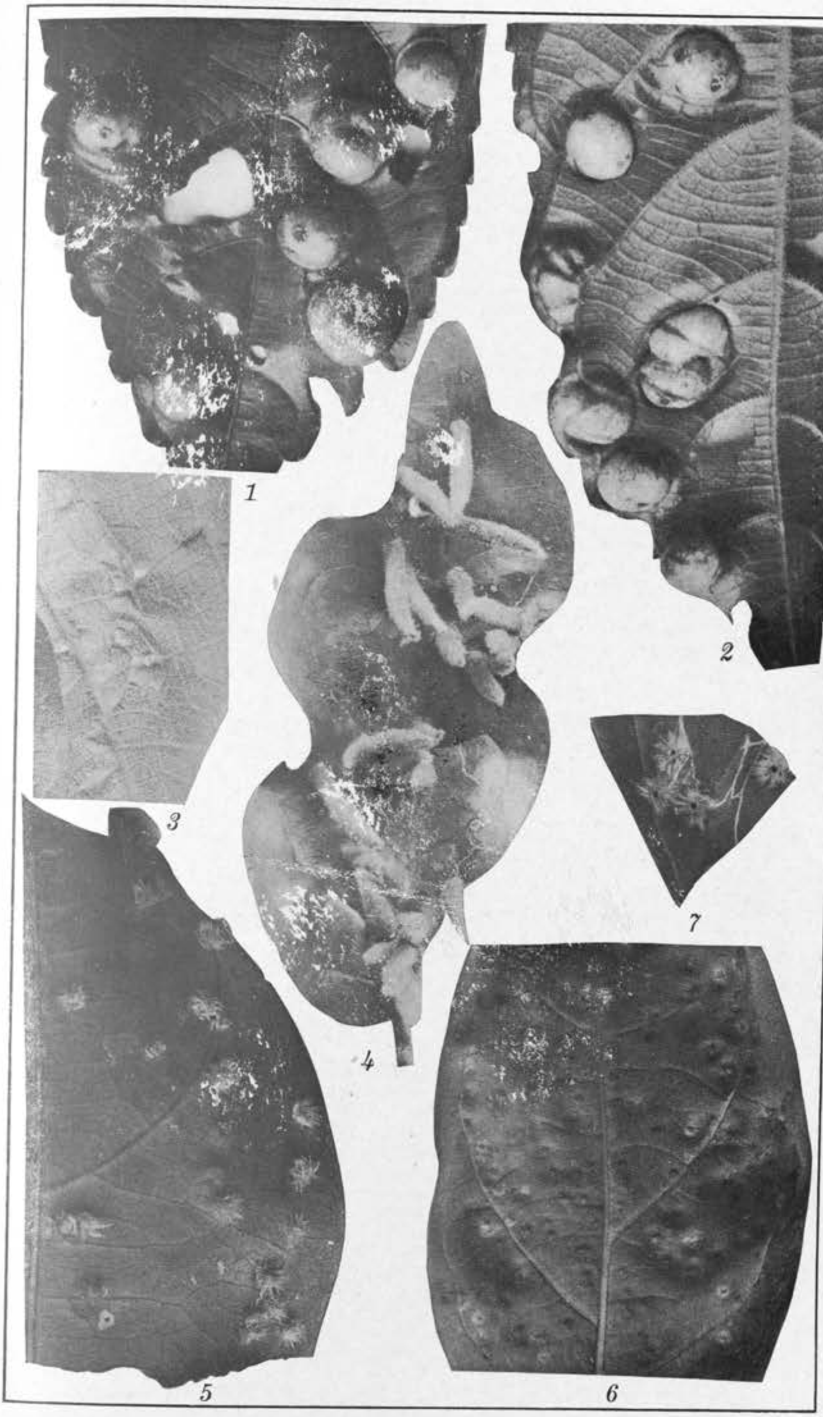


PLATE IX. PLANT GALLS.

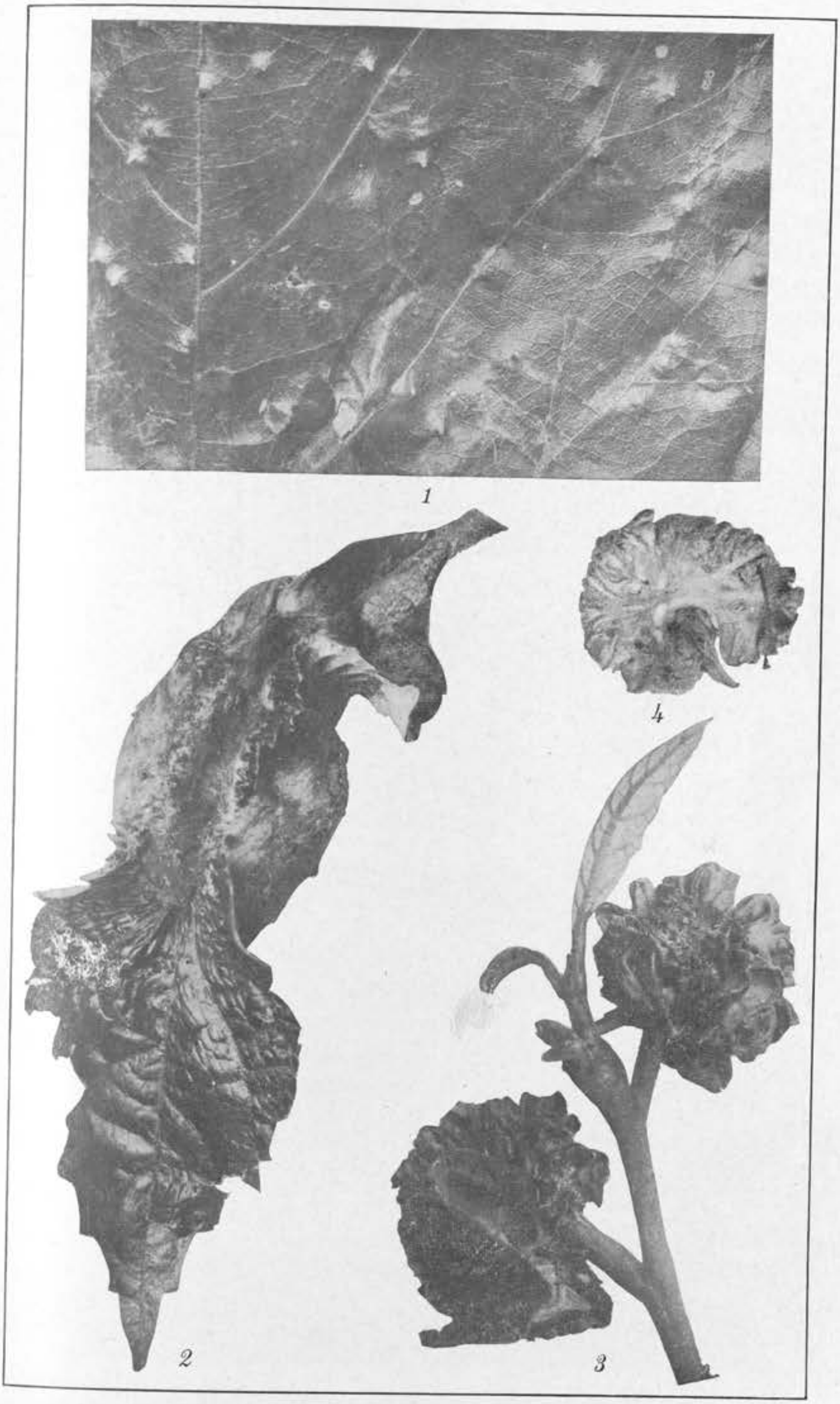
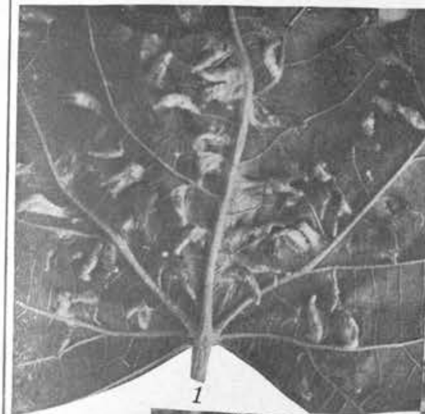


PLATE X. PLANT GALLS.



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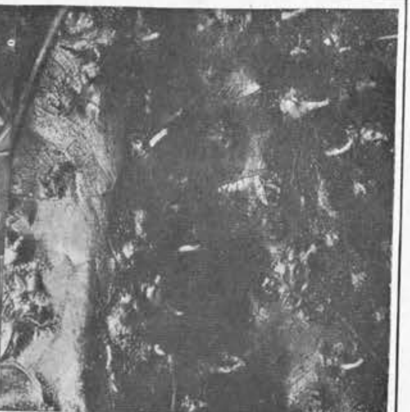

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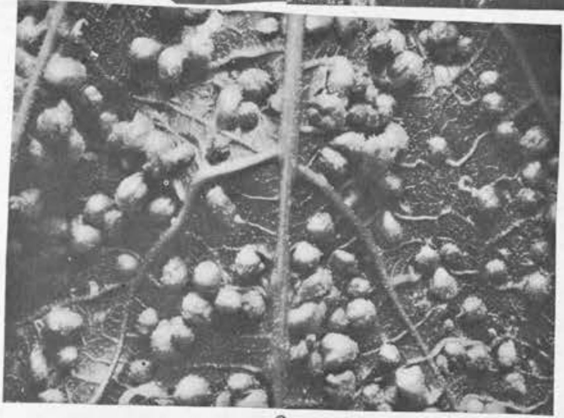

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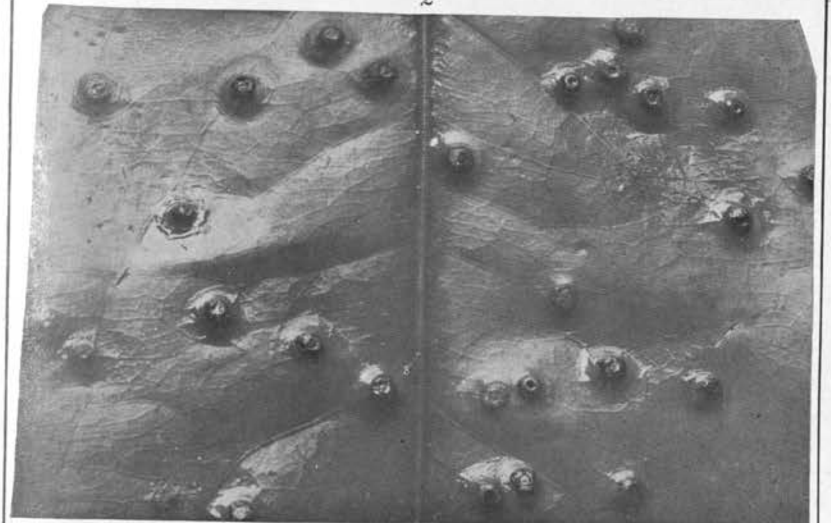

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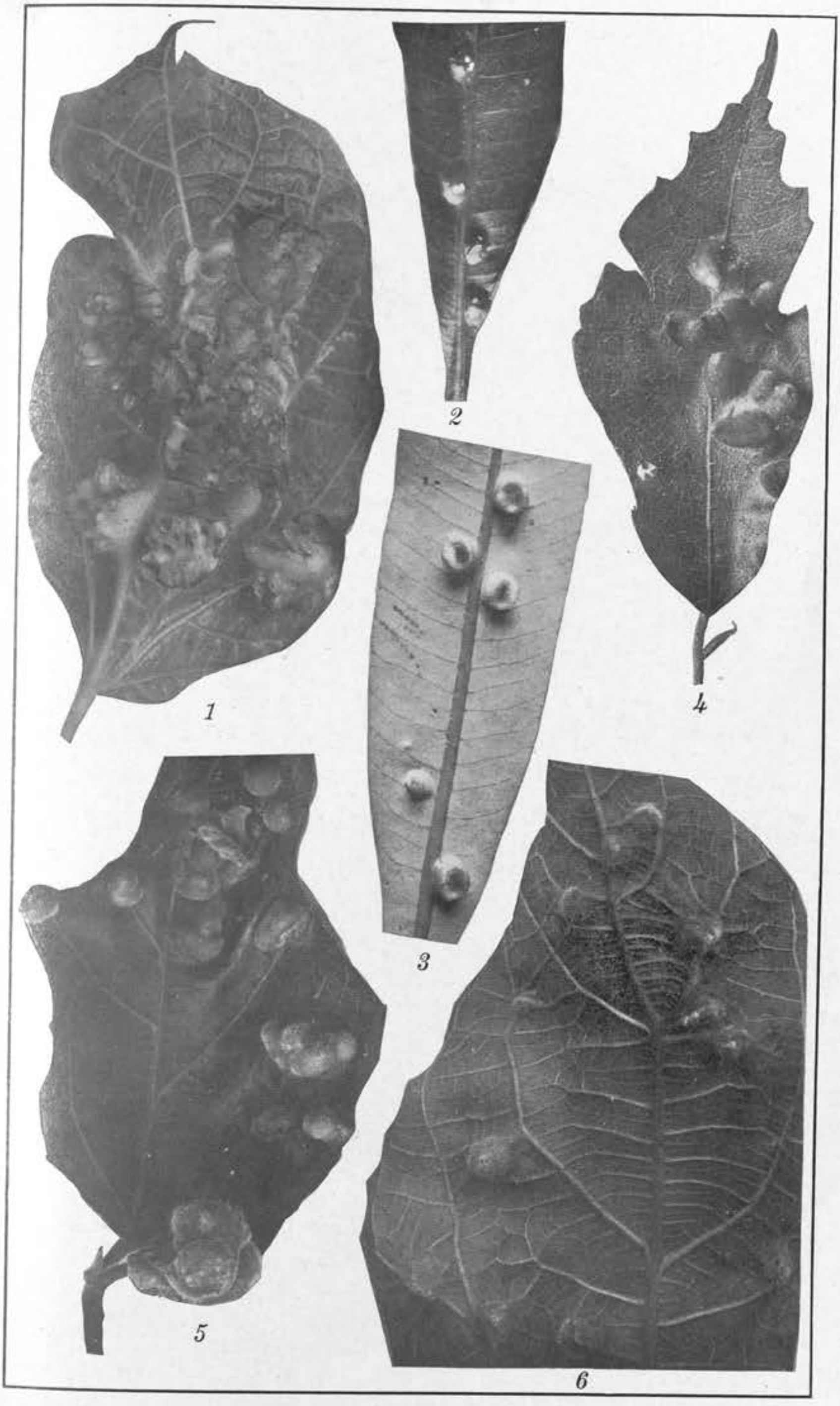

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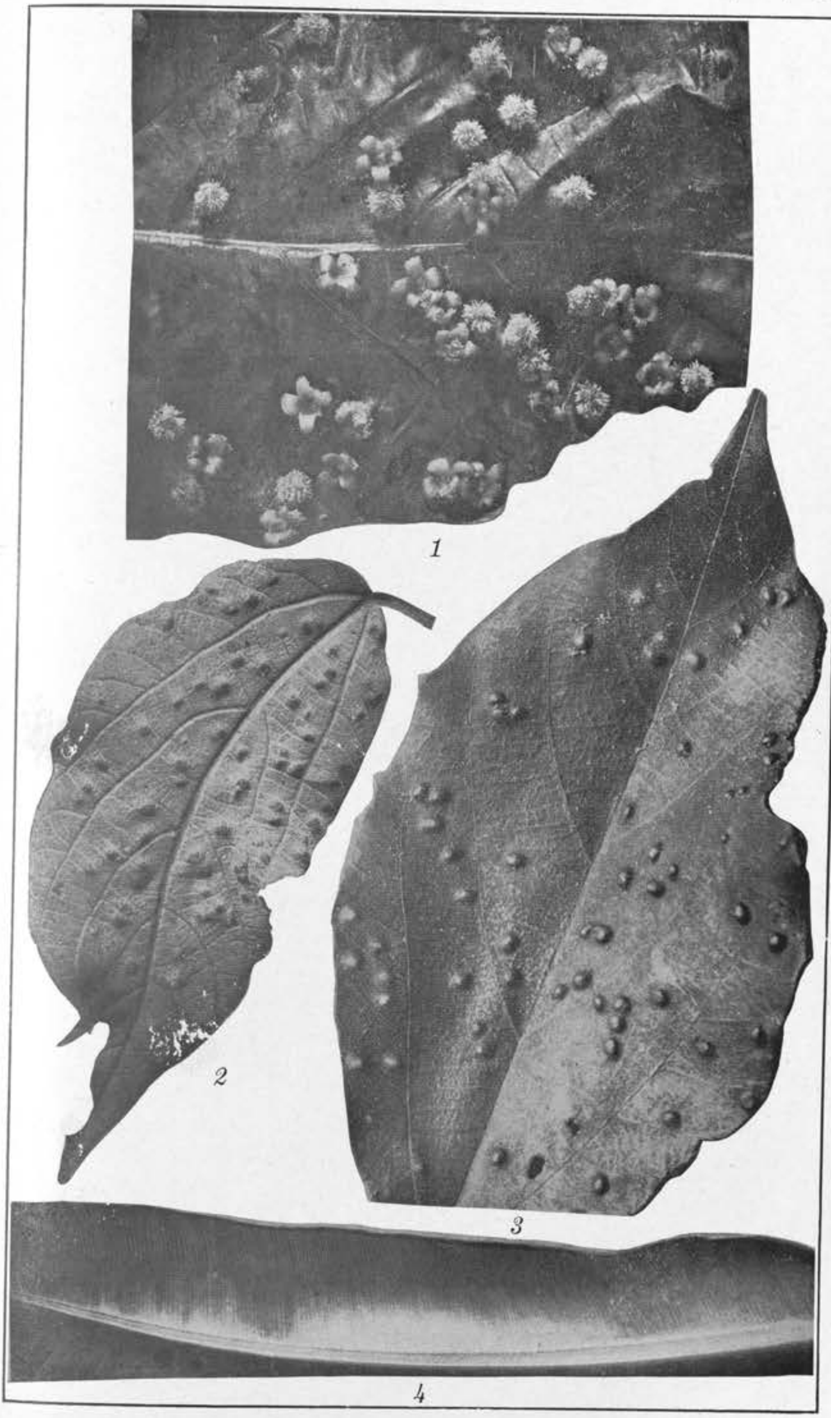

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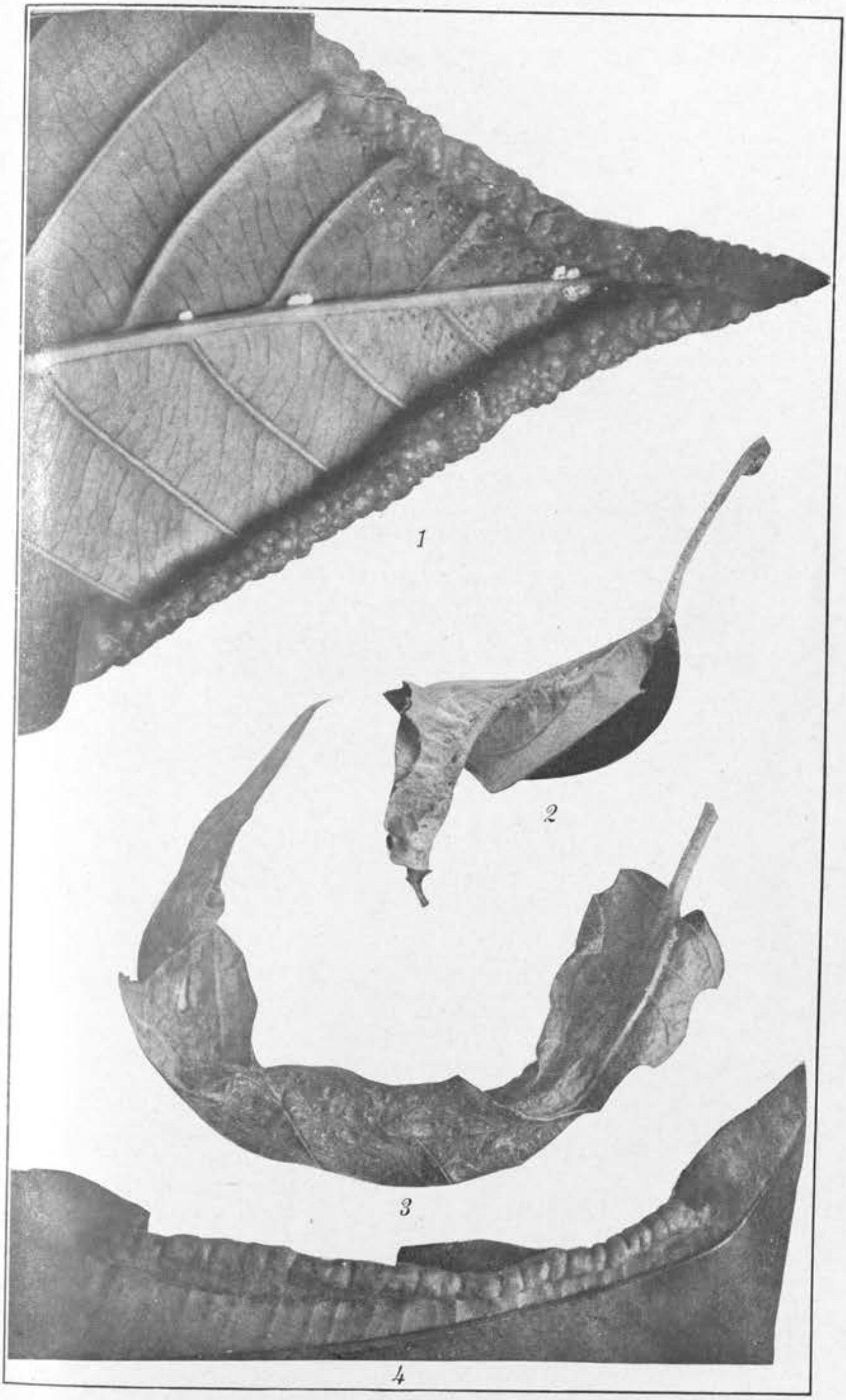

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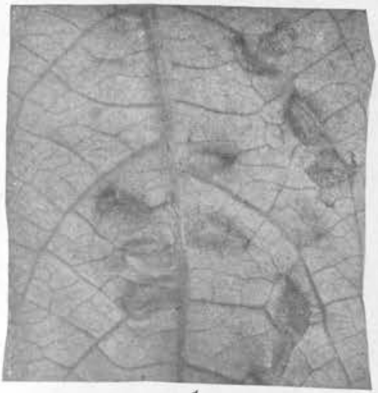

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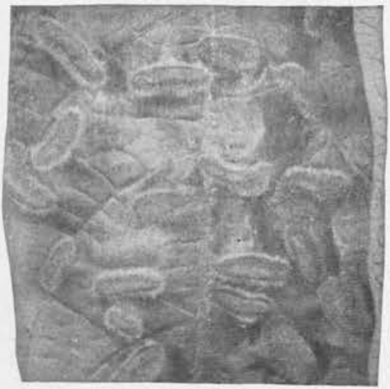

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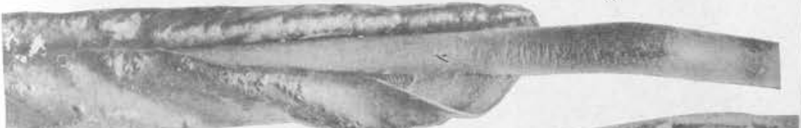

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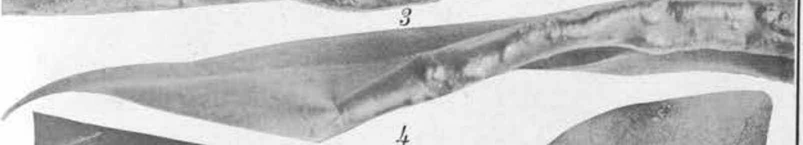

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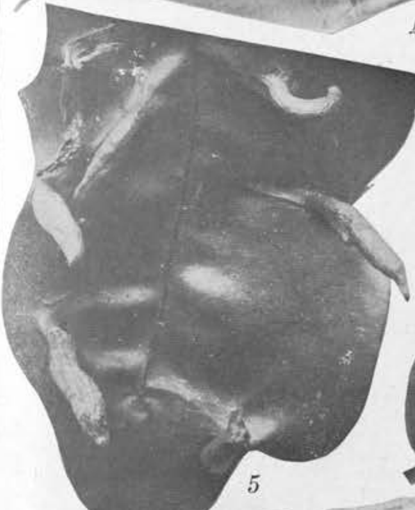

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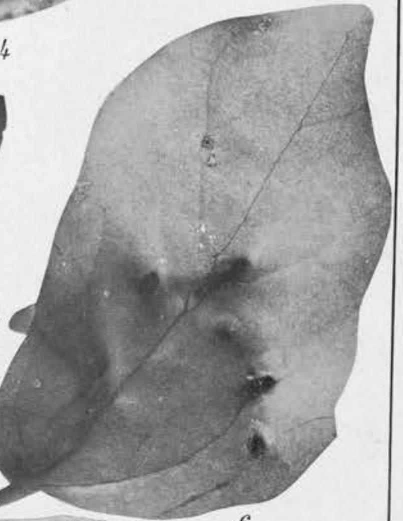

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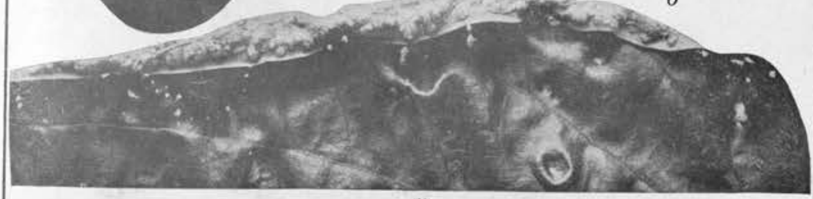

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PLATE XV. PLANT GALLS.

THE SPHECODINE BEES OF THE PHILIPPINE ISLANDS

By T. D. A. Cockerell

(University of Colorado, Boulder)

The genus *Sphecodes* Latreille consists of small or medium-sized bees, usually with red abdomen, widely distributed over both hemispheres. The venation, with three submarginal cells, well-developed stigma, and arched basal nervure, is much like that of *Halictus,* but the end of the female abdomen is quite without the characteristic rima of that genus. The second submarginal cell is narrow, higher than broad. Sixteen species are known from India, three from Japan, one from Formosa, and three from Java. There are also a species in Celebes, one in New Guinea, and one in Australia. Up to the present time only one Philippine species has been known, but four others may now be added. They may be separated by the following table:

Females 1
Males (joints of flagellum swollen or knotlike) 3
1. Mesothorax rough and extremely densely punctured...... bakeri Cockerell.
   Mesothorax smooth and shining between the well-separated punctures 2
2. Larger; head subcircular.. rotundiceps sp. nov.
   Smaller; head transversely oval.. transversus sp. nov.
3. Larger; head very broad; middle of abdomen red........... latifrons sp. nov.
   Smaller; head not very broad; abdomen dark............... tristellus sp. nov.

Sphecodes bakeri Cockerell.

Sphecodes bakeri Cockerell, Ann. & Mag. Nat. Hist. VIII 16 (1915) 489.

Mindanao, Dapitan (type locality) and Davao. Both from C. F. Baker.

Sphecodes rotundiceps sp. nov.

Female.—Length, about 9 millimeters; anterior wing, 8; black; with the first three segments of abdomen dark red, the others black; tarsi ferruginous at apex; head and thorax with white hair, conspicuous on sides of face, tubercles, a band extending from tubercles down pleura and sides of metathorax; head subcircular; mandibles dark reddish apically and with a small inner tooth; clypeus short and convex, shining, with large irregular punctures; front very coarsely and closely punctured, but with a bow-shaped transverse smooth band; top of head elevated, very convex, all the ocelli above the level of top of eyes; mesothorax shining, with very strong irregular punctures, more or less in rows; scutellum similarly sculptured; base of metathorax shining, very coarsely cancellate; tegulæ piceous with a rufous spot; wings strongly brownish; stigma piceous; abdomen shining, the first two segments with scattered but very distinct punctures; a strong constriction between first and second dorsal segments.

LUZON, Laguna Province, Los Baños (*Baker*). Nearest to *S. fumipennis* Smith, but smaller, with darker abdomen.

Sphecodes transversus sp. nov.

Female.—Length, a little over 7 millimeters; anterior wing, a little over 6 millimeters; black, with the abdomen castaneous red, black beyond the extreme base of fourth segment; mandibles obscurely red apically, and with an inner tooth; head very broad, transversely oval, face with rather thin white hair; clypeus roughened, depressed in middle; region behind the summits of eyes smooth and polished; mesothorax and scutellum polished, with scattered distinct punctures; base of metathorax with a series of large inclosed spaces; pleura conspicuously hairy; tegulæ piceous, the outer margin partly pallid; wings brownish, stigma dark reddish; legs very dark reddish, with white hair; abdomen shining, without distinct punctures; constriction between first and second segments moderate.

LUZON, Mount Maquiling (*Baker*). By the broad head this recalls the smaller *S. biroi* Friese, from New Guinea.

Sphecodes latifrons sp. nov.

Male.—Length, about 6.5 millimeters; anterior wing, 5.5 millimeters; black, the abdomen red as far as the middle of the third segment, but the basal segment dorsally reddish black; head very broad; face and front densely covered with white hair; mandibles red in middle; occiput strongly elevated; mesothorax and scutellum shining, with large and strong, rather close punctures; base of metathorax very coarsely, irregularly cancellate; small joints of tarsi pale ferruginous; tegulæ piceous basally, the outer side broadly hyaline; wings dilute fuliginous, stigma dark reddish; abdomen shining, the first two segments with fine but distinct punctures.

LUZON, Baguio, Benguet (*Baker*). Closely allied to *S. transversus*, but surely not its male, on account of the punctured abdomen, the closer and larger punctures of mesothorax, and the irregularly sculptured base of metathorax. The scanty hair on apical half of abdomen is white in *S. latifrons*, yellowish in *S. transversus*.

Sphecodes tristellus sp. nov.

Male.—Length, about 5.5 millimeters; black, with the tarsi pale ferruginous apically; apical margin of first abdominal segment and extreme base of second narrowly chestnut red, and sides of first two segments broadly suffused with red; head subcircular; clypeus shining, but strongly and quite closely punctured, not at all hidden by hair; scape short; third antennal joint about one-third as long as fourth; surface of flagellar joints microscopically reticulate; front and sides of face with much white hair, not however hiding the surface; mesothorax with very large, rather dense punctures, partly confluent in rows; tegulæ rufotestaceous, with the margin pallid; wings hyaline, the apical field dilute brown; stigma ferruginous; base of metathorax very coarsely cancellate; abdomen delicately and sparsely but distinctly punctured. The type has the second submarginal cell extraordinarily narrow on one side, while on the other the second transversocubital nervure is lacking. There is a distinct dorsal constriction between the first and second abdominal segments.

LEYTE, Tacloban (*Baker*). Resembles *S. javanicus* Friese, from Buitenzorg, Java, but is considerably smaller, with less red on abdomen.

ADDITIONAL NOTE ON CERATINA

Ceratina humilior (Cockerell).

Ceratina philippinensis nigrolateralis humilior COCKERELL, Philip. Journ. Sci. § D 11 (1916) 305.

A second specimen from the original locality agrees, and I now believe that this is a quite distinct species. The first abdominal segment is reddish orange, with a black spot on each side.

REVIEWS

A text-book | of | Physiology | for | Medical Students and Physicians | by | William H. Howell, Ph. D., M. D., Sc. D., LL. D. | Professor of physiology in the Johns Hopkins University, Baltimore | seventh edition, thoroughly revised | Philadelphia and London | W. B. Saunders Company | 1918. Cloth, pp. 1–1059 + 1–13. 307 illustrations. $5 net.

PREFACE TO THE SEVENTH EDITION

In this, as in former editions, no fundamental change has been made in the contents, arrangement of material, or the general principles of presentation which were originally adopted. But in the three years that have elapsed since the sixth edition the natural expansion of physiological and medical research has yielded much new information. To incorporate the main features of this added knowledge it has been necessary to make many alterations. Throughout the work additions, substitutions, and omissions have been used freely in order to bring the book up to date as nearly as possible.

It is now thirteen years since the first edition appeared. During this period the author has tried faithfully in the successive editions to keep the book in line with our advancing knowledge. It is not probable that he has been wholly successful in these attempts, for the literature bearing upon the subject has increased steadily in volume and complexity, but certainly he has not altogether failed. The book has moved with the current of contemporary physiological thought, as a text-book must if it is to be useful to its clientele of students.

Pathological | Technique | A Practical Manual for Workers in | Pathological Histology and Bacteriology | including | Directions for the Performance of Autopsies and | for Clinical Diagnosis by Laboratory Methods | by | Frank Burr Mallory, A. M., M. D. | associate professor of Pathology, Harvard Medical School; pathologist | to the Boston City Hospital | and | James Homer Wright, A. M., M. D., S. D. | pathologist to the Massachusetts General Hospital; assistant professor of | pathology, Harvard Medical School | seventh edition | revised and enlarged | with 181 Illustrations | Philadelphia and London | W. B. Saunders Company | 1918. | pp. 1–55.

PREFACE TO THE SEVENTH EDITION

The book has been rearranged in this edition with the object of making it more useful. Among other changes the postmortem technique has been put at the end. The revision has been fairly thorough, but not so complete as could be wished owing to the war.

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